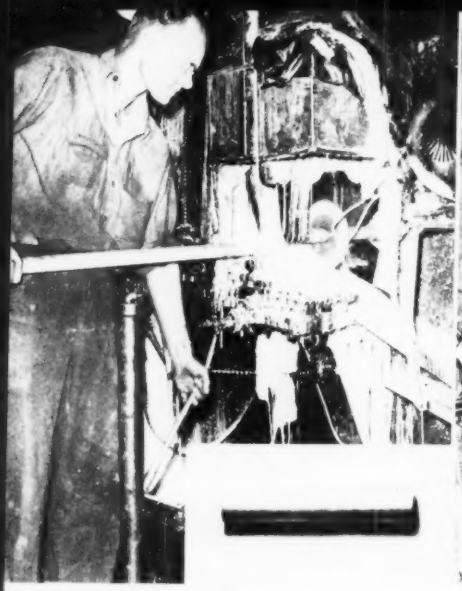
TECHNOLOGY DEPARTMENT

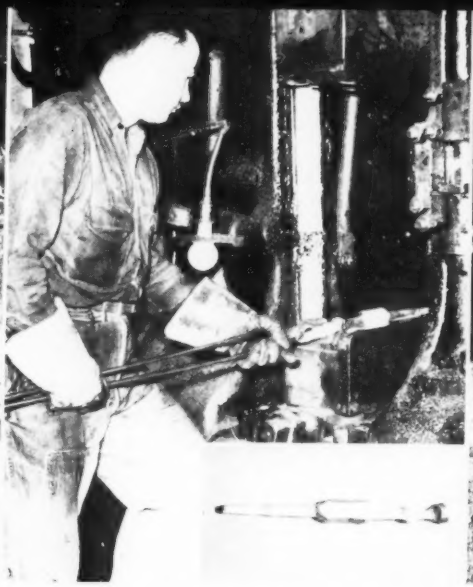
TECHNOLOGY REVIEW

February 1949

PUBLIC LIBRARY
FEB 3 - 1949
DETROIT

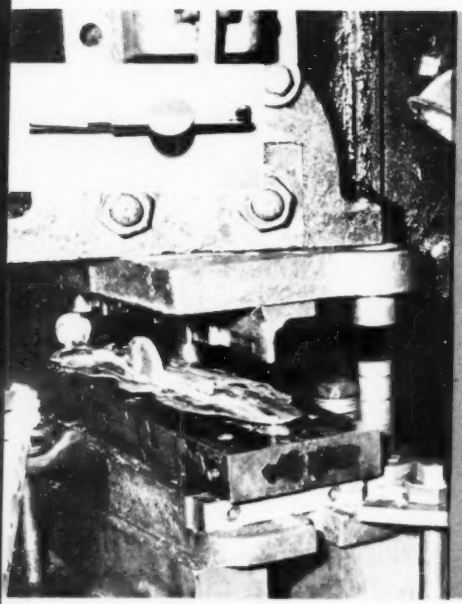


Cutting Bar



Lengthening and Shaping

Shaping to the Die

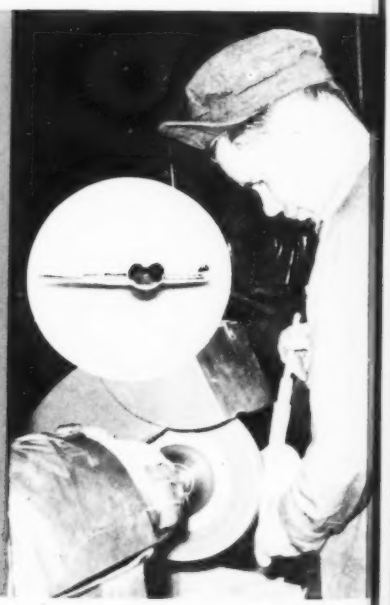


Trimming the Flash

FORGING ALUMINUM

into

Pressure Cooker Tops



Finishing and Polishing

The Harvey Metal Corporation

HAROLD B. HARVEY '05

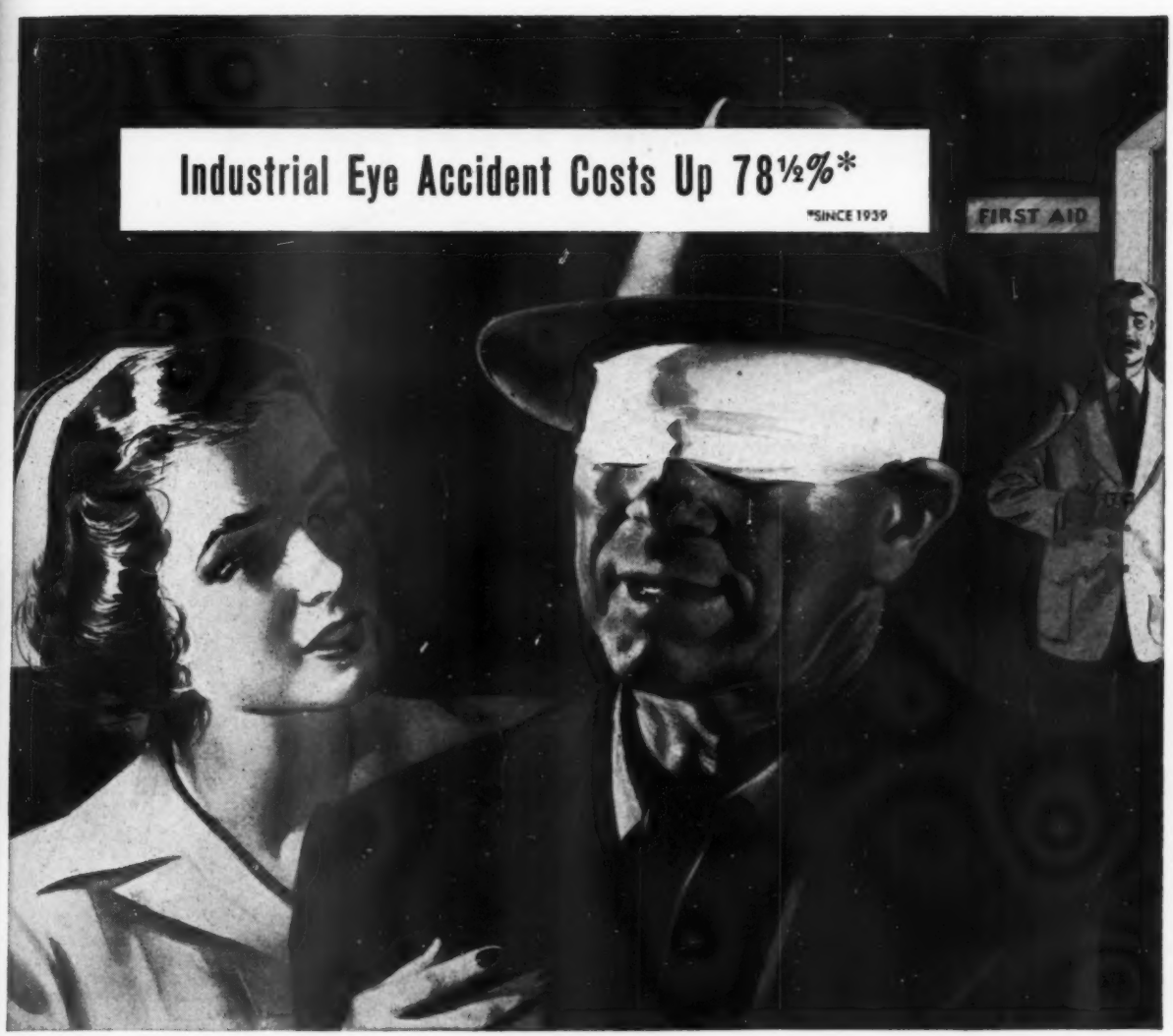
Engineers and Manufacturers

74th Street and Ashland Avenue — Chicago 36, Illinois

FORGINGS IN ALUMINUM — BRASS — BRONZE — COPPER — MAGNESIUM — MONEL — ALLOYS

MACHINING FACILITIES

Die
hing
OYS



Here's One Expense Cost-Conscious Management has cut—to Rock Bottom in these Days of Rising Costs

Year after year, industrial eye accidents embezzle your profits and cut your production by sidelining able men, putting machines in the hands of less experienced workers, lowering morale, hiking claims and insurance costs. All this on top of the cost of medical service!

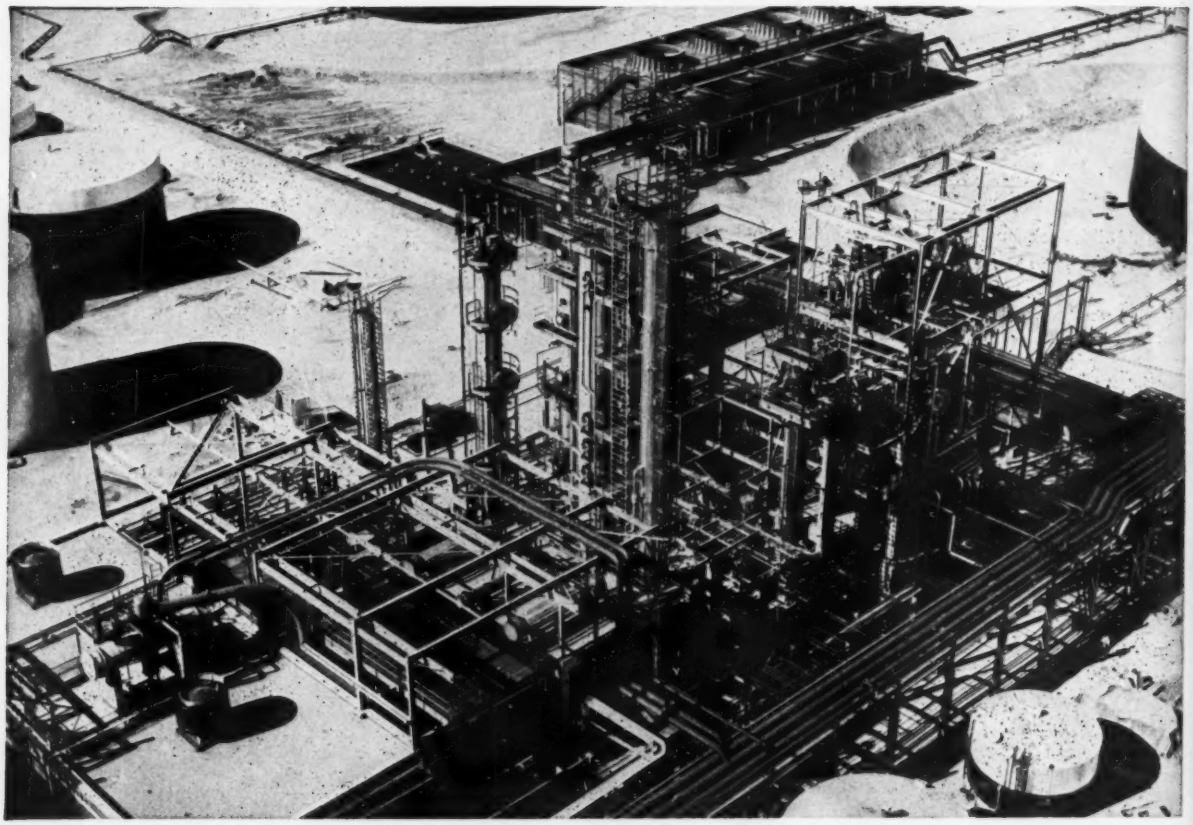
Aware that 98% of industrial eye accidents are preventable, many companies have solved this problem by installing an adequate eye protection program with results like this: cost of eye accidents in year prior to program, $4,262.00; cost of eye accidents in first year of program, $204.59! Ask your AO Safety Representative how an AO Eye Protection Program can cut your costs.

American Optical — Safety Division

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

THE TECHNOLOGY REVIEW, February, 1949. Newsstand Edition. Vol. LI, No. 4. Published monthly from November to July inclusive at 8 Harmony Place, Brattleboro, Vt. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription. $4.00. Entered as second-class matter at the Post Office at Brattleboro, Vt., under the Act of March 3, 1879.

Crude thruput doubled... gasoline octane level raised...



Denver, Colorado Refinery of Continental Oil Company, with catalytic cracking, gas recovery, catalytic polymerization and L.P.G. Fractionating units designed and built by Lummus.

...an interesting example of integrated expansion

The new Lummus-built catalytic cracking unit at Continental's Denver Refinery was recently completed. Despite unfavorable weather conditions it went on stream about the middle of November, and within two days it was operating at design capacity.

The catalytic cracking unit was part of an integrated expansion program that included the design and construction by Lummus of three other new units—gas recovery, catalytic polymerization, liquid propane gas fractionation—and the modernization by Lummus of a thermal cracking unit.

Continental's Denver Program is an interesting example of refinery expansion accomplished by integrating new units with modernized existing facilities. This program practically doubles the crude thruput at Denver and raises the octane level of the finished gasoline.

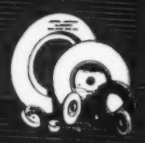
Lummus engineers are available for a thorough study of individual problems involving the modernization or expansion of existing facilities and the projection of new programs.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

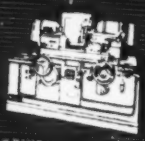
LUMMUS

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas
LONDON—525 Oxford Street, London, W.1, England

OIL STEEL CHEMICAL



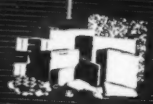
GRINDING WHEELS



GRINDING MACHINES

REFRACTORIES

NORBIDE



NON-SLIP FLOORS

LABELING MACHINES

ABRASIVE PAPER AND CLOTH • • • SHARPENING STONES

Introducing . . .

NORTON

a continuing symbol of

NORTON QUALITY

. . . the same wide variety of products . . . backed by the same extensive research . . . backed by the same manufacturing skill in a modernized plant—now marked by a modernized version of the familiar Norton trade-mark.

Every Norton product—from Worcester as well as from the Behr-Manning division at Troy—will bear this symbol of Norton quality.

The main Worcester plant of Norton Company—world's largest producer of abrasive products

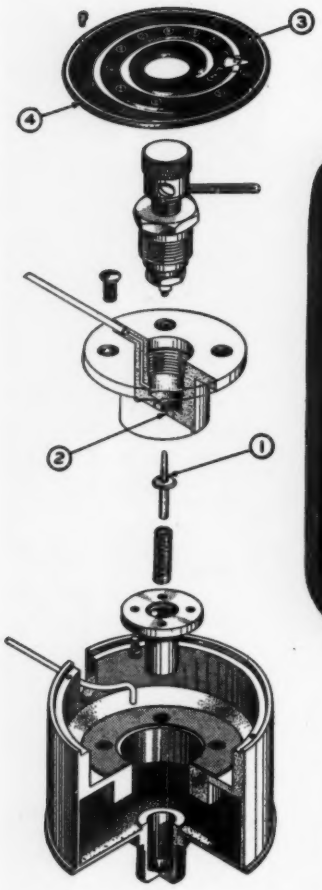
NORTON COMPANY • WORCESTER 6, MASS.

*Behr-Manning, Troy, N. Y. is a Norton Division

MASONEILAN

Mason-Neilan Offers INTEGRAL RESET

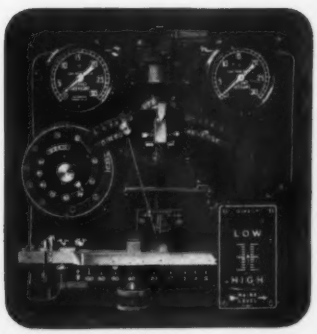
in the 12,000 Series Level Controllers



Resistance Unit

1. Precision-machined tapered stainless steel plug
2. Tapered orifice
3. Actual reset rates — graduations divided by 20
4. Spiral scale permits nearly 2 full turns. Readings at smaller reset rates have greater spacings

Model 12610-20 Proportional-Reset Controller and Pneumatic Transmitter



Model 12610 Proportional-Reset Controller

Model 12610 Controller

Masoneilan proportional-reset level controllers have the entire reset mechanism *inside* the instrument case.

Reset is thus accessible, compact and protected.

The 12000 Series controllers with pneumatic reset are *package* units, complete and standard with the reset bellows and resistance unit integral, built-in. Masoneilan duplex level controllers and controller-transmitters also have this reset.

There are no external connections or adjustments to make. There is no external piping. And since the reset is an integral part of the controller and not an external appliance, the reset mechanism is always accurately calibrated, with graduations on a ten-inch scale proportional to actual reset rates.

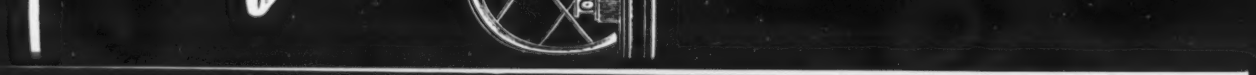
When to Specify Reset . . .

1. When you want to get maximum vessel surge capacity at all times and in the presence of large and sustained load changes.
2. When smooth, uniform, controlled flows are essential to process operation.
3. When the level controller pneumatically sets the set point of a flow controller, or of several flow controllers in split-stream operation.

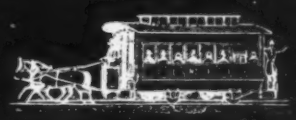
MASON-NEILAN REGULATOR COMPANY

1190 Adams Street, Boston 24, Mass., U.S.A.

Philadelphia • Houston • Pittsburgh • New York • Buffalo • Chicago • St. Louis • Cleveland • Tulsa • Atlanta
Denver • Los Angeles • San Francisco • Cincinnati • Mason Regulator Company of Canada, Ltd., Montreal and Toronto

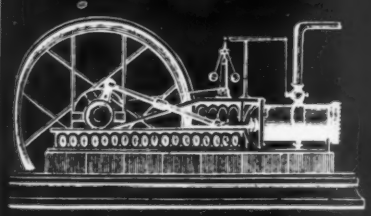


1882



For nearly three-quarters of a century . . .

For nearly three-quarters of a century, Cabot has produced carbon black. More than two billion pounds of Cabot carbon black has found its way into industries ranging from the manufacture of rubber tires, inner tubes, footwear and mechanical rubber goods, to printing ink, paint, varnish, lacquer, plastics, dry cell batteries, fertilizer and paper.



Do you know all you should about the wide range of properties this versatile material displays? It may help your process or product. We will gladly furnish technical data.

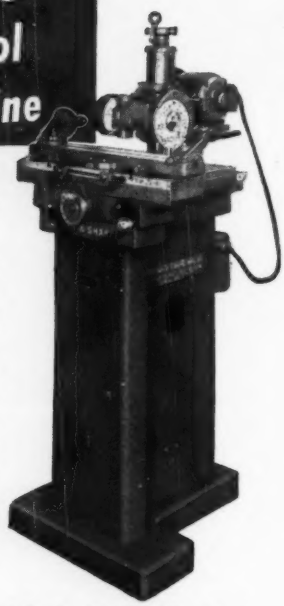
GODFREY L. CABOT, INC.

77 FRANKLIN ST., BOSTON 10, MASS.

CABOT

Developed to Save You Money

The NEW No. 5 Cutter and Tool Grinding Machine



• This new Brown & Sharpe machine is specifically designed for sharpening small cutters—especially end mills, reamers and similar tools—more efficiently. Its supersensitivity speeds up set-up and operation. Its compact size saves on floor space and investment.

The following features typify the advanced engineering design of this new grinding machine . . . an ingenious, roller-bearing table and a double-ended ball bearing wheel spindle with super-precision, permanently-sealed, grease-lubricated bearings. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

BROWN & SHARPE BS

GEARED FOR THE FUTURE

It has been DIEFENDORF policy through the years to build gears according to the specifications of the designers—the manufacturers who have created the machine of which the gear is just a part.

To keep faith with that manufacturer, DIEFENDORF GEARS are built for service into the future. Good design and construction from good materials.

DIEFENDORF GEAR CORPORATION
Syracuse 1, New York

DIEFENDORF GEARS

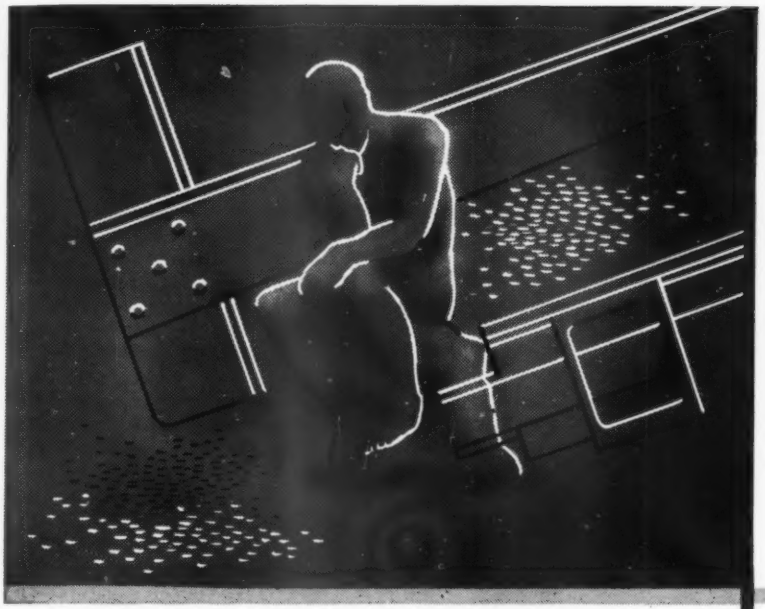
THE TABULAR VIEW

He flies through the air bent on achieving the most rapid transportation possible, yet the typical air passenger seldom gives thought to safety until tragic crashes come to his attention. The case of safety in the air is ably and authoritatively presented in the personal opinions (page 215) of W. MACK ANGAS, '17, Rear Admiral, director of the Atlantic Division of the Bureau of Yards and Docks, Civil Engineer Corps, United States Navy, and Lieutenant Commander WILLIAM T. HARDAKER, Naval Air Technical Training Command, Memphis. Although not expressing official Navy views, both officers have had extensive experience in flying, and in airport design and construction for the Navy. Admiral Angas is already favorably known to Review readers for his articles on maritime matters. As one of its new authors, The Review welcomes Commander Hardaker who has flown more than 2,700 hours since getting his wings in 1939, mostly in the Central, South, and Southwest Pacific during the first 18 months of World War II.

With the greatest of ease and with good (if misguided) intentions, large numbers of this nation's agriculturalists have contributed to destruction of this country's topsoil. The problem of soil conservation is gradually becoming recognized as a major factor in providing a food supply for the world's steadily growing population. In this issue (page 221) EDWARD H. GRAHAM outlines some of the projects now in progress to conserve soil, and indicates the extent to which engineering is necessary in this program. Dr. Graham is a graduate of the University of Pittsburgh (B.S., 1927; Ph.D., 1932), and for several years was associated with the Carnegie Museum in Pittsburgh as assistant curator of botany. Since 1937 he has been with the United States Department of Agriculture where he is now chief of the Biology Division of the Soil Conservation Service.

The daring young man who, palette in hand, appears to daub undecipherable patches of oil on canvas, may have a message for the conventionalists after all. PAUL MEADOWS turns to their writings for an interpretation (page 220) of the work of the contemporary rebel painters. Dr. Meadows, Associate Professor of Sociology at the University of Nebraska, has been an avid student of social movements and the human aspects of modern industrialism for many years, as his articles in The Review testify.

On the flying trapeze of easy money for mathematical accomplishment, many an abecedarian, and occasionally a scholar, has come to grief. Attracted by prizes which have been offered, many tackle problems beyond their ability for utilitarian reasons, as WILLY LEY points out (page 225). Mr. Ley, an Editorial Associate of The Review, for the past five years, is probably best known for his writings on matters pertaining to rockets. He also delves into other aspects of science writing, including a number of books, of which his latest is *The Lungfish, the Dodo, and the Unicorn.*



Thinking of improving

"Improving" any machine really means increasing its productive capacity. That means tinkering with speeds and weights and strength—ending up with alloy steels.

Which alloy steel?—the one that meets physical requirements at the lowest cost. Molybdenum steels fill that bill. Good hardenability, plus freedom from temper brittleness, plus reasonable price enable them to do it.

Send for our comprehensive 400-page book, free; "MOLYBDENUM: STEELS, IRONS, ALLOYS."

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

C2

MARTIN-HUBBARD CORPORATION

Engineering Consultants

Computers — Servomechanisms

Instrumentation for Nuclear Research

Applied ultrasonic research and development

Design and construction of scientific instruments to your performance specifications

Complete engineering of original or unique electrical and mechanical devices and machinery

Technical reports

11 BEACON STREET

BOSTON 8, MASSACHUSETTS, U. S. A.

Telephone: CApitol 7-6990 "Cable Address MARHUB Boston"

GET THIS STARRETT AID

TO FASTER, MORE ECONOMICAL METAL CUTTING

WRITE FOR YOUR FREE CUTTING CHART TODAY

Address Dept. "L"

This handy slide rule chart gives you instant information for cutting any material with hacksaws or band saws.

HACKSAW SIDE tells the recommended number of teeth per inch for hand blades and the pitch, speed and feed for power blades for cutting all metals. Also gives recommended readings for torque wrench settings and fixed tension devices.

BAND SAW SIDE gives correct length and width of blade for any standard band saw machine and recommended number of teeth per inch and speed in feet per minute for cutting any material.

Starrett

Standard of Precision

MECHANICS' HAND MEASURING TOOLS AND PRECISION INSTRUMENTS · DIAL INDICATORS · STEEL TAPES · HACKSAWS AND BAND SAWS · PRECISION GROUND FLAT STOCK

Buy Through Your Distributor

THE L. S. STARRETT CO. *World's Greatest Toolmakers* · ATHOL, MASSACHUSETTS, U. S. A.

MAIL RETURNS

Continental Contributors

FROM LLOYD ESPENSCHIED:

Permit an outsider to express his appreciation of the article on Ampère in the December, 1948, issue of The Review, written by David and Charlotte B. Landau. It's a beautiful picture of the times, the man and his accomplishments; an appropriate recognition of one of the greatest of electrical scientists.

Such an article should be relished the more because we in the United States are none too well informed on the Continental contributors to electricity and magnetism, the result, apparently, of the language barrier, of the fact that the Continental contributors were divided between a number of nationals, and perhaps have been lacking in publicity sponsors, certainly in the English language, compared to the British.

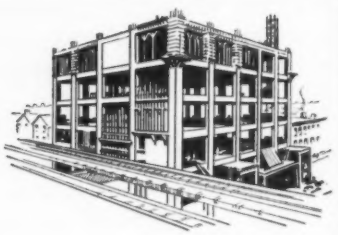
Before me is Ampère's book of 1822, *Recueil d'Observations Electro-Dynamiques*. The contents of it are well summarized in the international language of the 10 plates of figures. Here we see some of the earliest illustrations of the electrical conductor wound up into a coil* to enhance the magnetic effect; long, thin coils, short, fat coils (pancake coils), and single loops mounted delicately on pivots and capable of rotary displacement and thus showing mechanically the inductive action between two circuits carrying current. Here we see some of the carefully constructed apparatus with which Ampère determined some of the primary laws of electromagnetism, measured the interaction as a function of distance and angle between coils, which he then expressed mathematically.

Perhaps our conception of his contribution would be clarified if, instead of using the term "electrodynamics," which has little currency today, we simply said that following Oersted's discovery, it was Ampère who first elucidated electromagnetism and supplied the primary knowledge of electromagnetic-mechanical action. He was the

* The simple but basic contribution of wrapping a wire up into a coil, and thus "multiplying" the effect of a single wire, Ampère shares in the year 1820 with Schweigger of Halle who orginated the galvanometer.

(*Concluded on page 242*)

Speed with Economy



We have recently erected our 7th building for E. A. Laboratories—the first erected in 1919.

The E. A. Laboratories is but one of many companies that have evidenced similar confidence in our organization.

W. J. BARNEY CORPORATION

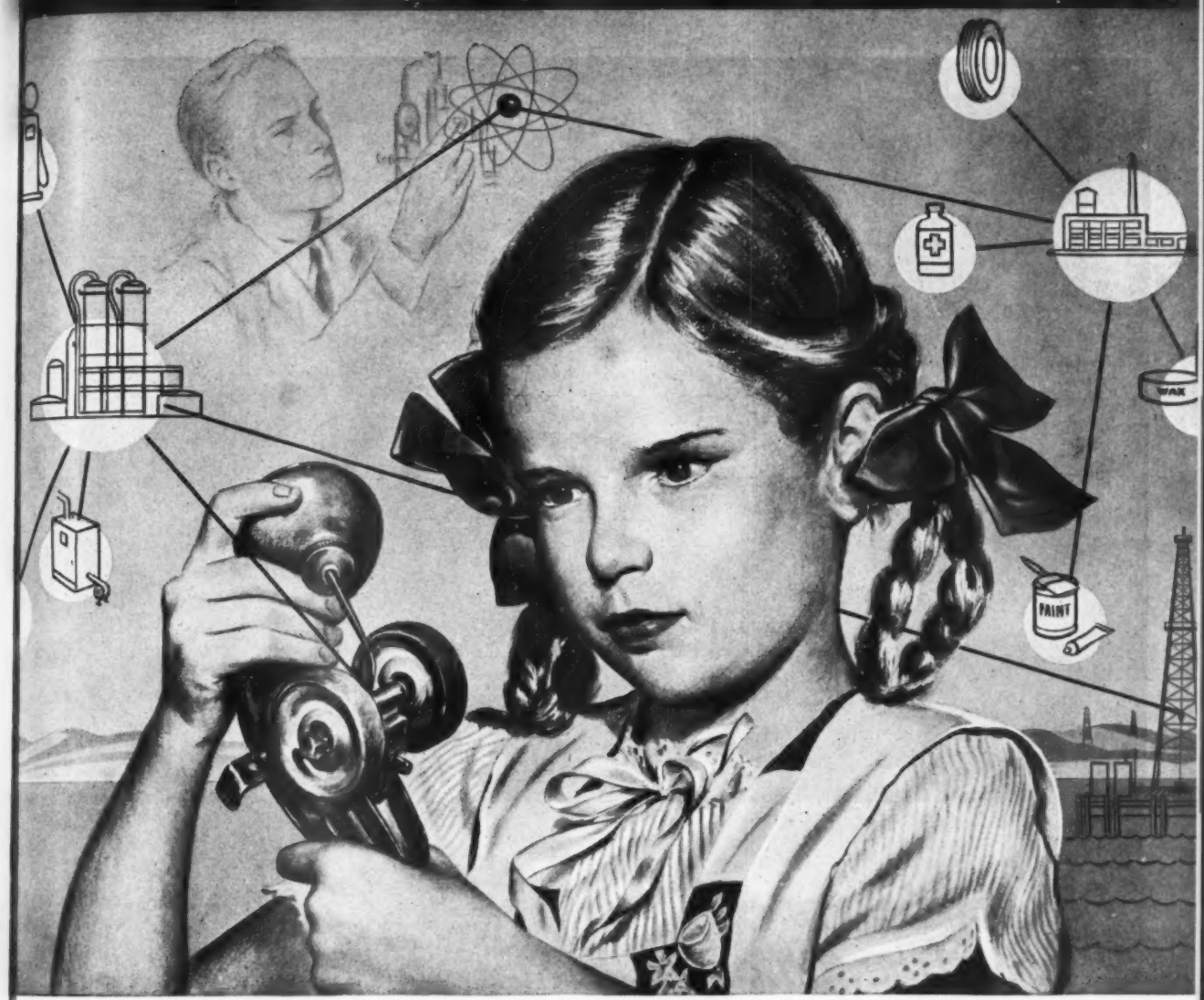
FOUNDED 1917

101 PARK AVENUE, NEW YORK

INDUSTRIAL CONSTRUCTION

Alfred T. Glassett, '20, Vice President

"—The seeds of godlike power are in us still"—MATTHEW ARNOLD



More and more . . . and better oil

UNDER THE WATERS just off the Gulf Coast alone . . . lie vast new oil fields that may almost double America's oil reserves.

This rich discovery is just one more phase of the better-than-ever job the oil industry is now doing to meet our soaring demands. And back of that job are today's superior skills, advanced engineering, and *better materials.*

Such hard metals as tungsten carbide, used in drills, help make it possible to cut more than three miles into the earth. Essential valves, pumps, and even fractionating towers made of *carbon* are virtually 100% proof against highly corrosive acids.

Such better materials as stainless steel defy heat, pressure and corrosion in refinery operations. With the new oxy-acetylene pressure welding, pipelines can be more swiftly linked into single strong units that extend for hundreds of miles.

Better chemicals, also! Solvents that purify our oil . . . chemicals that draw offensive elements from our gasoline and provide us with anti-knock compounds. All these are helping bring us better medicines, waxes, cosmetics, paints . . . to name only a handful of today's hundreds of superior petroleum products.

The people of Union Carbide produce these and many other materials that help supply us with more and better petroleum products. They also provide hundreds of other materials to help science and industry maintain American leadership . . . in meeting the needs of mankind.

FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which shows how science and industry use UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

UNION CARBIDE
AND CARBON CORPORATION

30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

Products of Divisions and Units include

LINDE OXYGEN • PREST-O-LITE ACETYLENE • PYROFAX GAS • BAKELITE, KRENE, VINYON, AND VINYLITE PLASTICS
NATIONAL CARBONS • EVEREADY FLASHLIGHTS AND BATTERIES • ACHESON ELECTRODES

Liquid coal
—the Oil of the Future

Petroleum has been aptly called "strategic mineral Number One in world affairs." Yet proved oil reserves, particularly in the United States, are alarmingly low. Experts may differ as to when the earth's crust will yield its last barrel, but none denies the seriousness of the problem posed by rate of consumption vs. known reserves.

Fortunately, there are alternative sources —almost unbelievably abundant—from which modern alchemy can synthesize petroleum products. These, principally, are coal, natural gas and oil shale—our major carbon deposits.

Coal, by its abundance, is the hope of the future. Known beds could provide America's oil needs for a thousand years. But coal is presently more difficult and costly to convert to oil than natural gas, of which there is a supply about equal to our petroleum reserves. Shale, at the present stage of development, has practical possibilities mainly as a source of heavy fuel oil and Diesel fuel.

Plants for the conversion on a commercial scale of all three basic materials are under way, after successful laboratory and pilot plant tests. Natural gas appears at present to be the one source from which synthetic oil can compete on equal terms with petroleum. With major oil company backing, both the Texas and Kansas gas fields are being utilized.

To this important program, Combustion Engineering is contributing its vast experience in the fields of fuel burning, steam generation (both natural and forced circulation), heat transfer and fluid flow. C-E equipment now being built for natural gas synthesis plants includes steam generating units, separately fired superheaters, gas generators and catalyst reactors. Here, as on other industrial frontiers, you will find the C-E flame—symbolizing Combustion's part in the better utilization of heat. B-236

C-E

COMBUSTION ENGINEERING-SUPERHEATER, Inc.

200 MADISON AVE. • N. Y. 16, N. Y.

Products include all types of Boilers Furnaces • Pulverized Fuel Systems Stokers • Superheaters • Economizers Air Heaters. *Also,* Pressure Vessels Chemical Recovery Equipment • Flash Drying Systems • Sewage Incineration Equipment • Domestic Water Heaters.

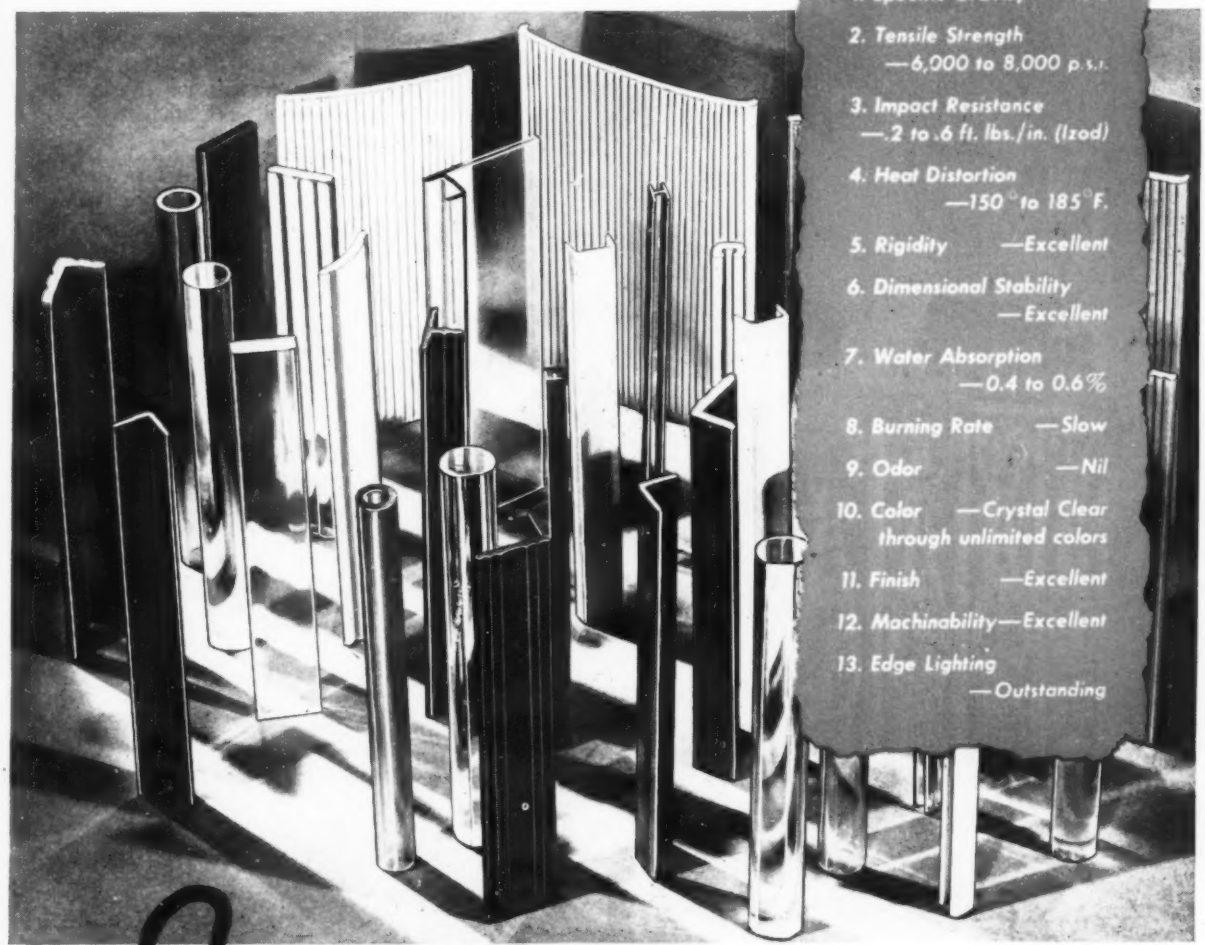
SANDEE EXTRUDED *METHYL METHACRYLATE* SECTIONS

METHYL methacrylate under the trade names *Plexiglas* and *Lucite* proved during the war that serviceability equalled its outstanding beauty. Sandee is happy to add *extruded acrylic sections* to its ever growing list of successful Sandee extrusions.

Now, simple and complex shapes in small and moderate sizes and in crystal clear, transparent or translucent color can be extruded to add all of the inherent beauty and serviceability of this material to your products. Rods and tubes in sizes under ½" diameter could also be extruded to meet your specifications. Study the excellent physical and chemical properties of this material, add its outstanding visual appeal, then call on Sandee for those long sought, specially designed sections.

PROPERTIES OF *Sandee* METHYL METHACRYLATE

1. Specific Gravity —1.18
2. Tensile Strength —6,000 to 8,000 p.s.i.
3. Impact Resistance —.2 to .6 ft. lbs./in. (Izod)
4. Heat Distortion —150° to 185° F.
5. Rigidity —Excellent
6. Dimensional Stability —Excellent
7. Water Absorption —0.4 to 0.6%
8. Burning Rate —Slow
9. Odor —Nil
10. Color —Crystal Clear through unlimited colors
11. Finish —Excellent
12. Machinability —Excellent
13. Edge Lighting —Outstanding



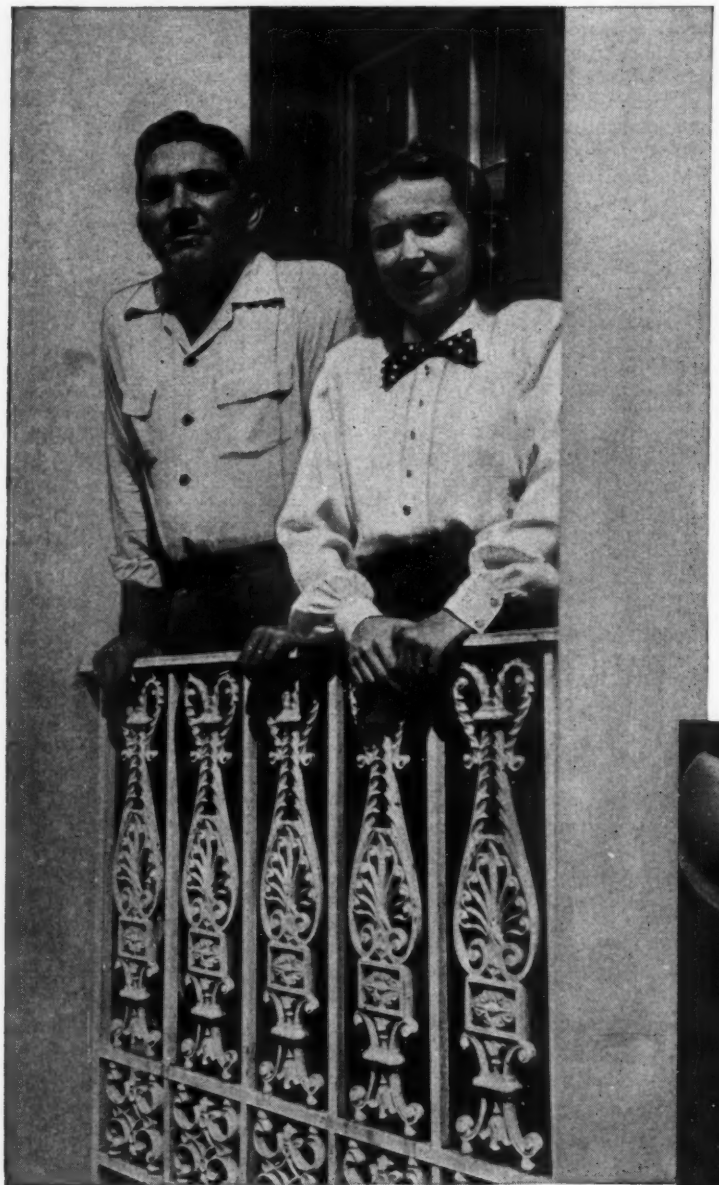
SALES REPRESENTATIVES IN 19 PRINCIPAL CITIES

Sandee Manufacturing Company

5050 FOSTER AVENUE • CHICAGO 30, ILLINOIS

EXTRUDED PLASTICS AND SPECIAL TOOLS

Let the McGehees help you pick your next tires!



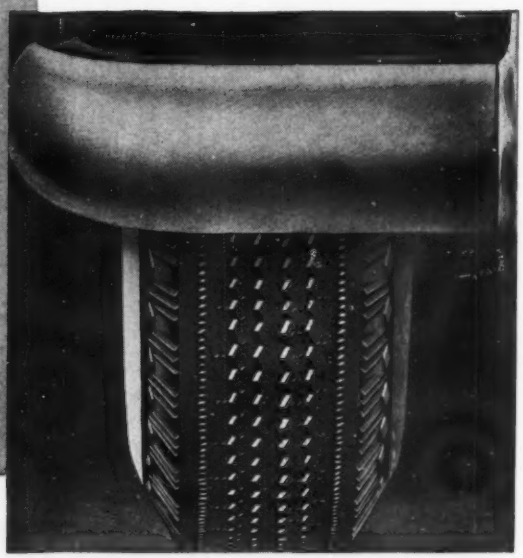
We think you'll like "THE GREATEST STORY EVER TOLD"
—every Sunday—ABC Network

MR. AND MRS. WILLIAM C. MCGEHEE, of Natchez, Miss., have Super-Cushions on *their* car—so they know what these amazing tires will do for *your* car! Here's what Mr. McGehee says:

"I've driven thousands of miles since I put Super-Cushions on my small car, and they've made it ride and handle as smoothly as a big car. In logging operations, I drive over rough corduroy roads, yet these tires absorb the shock and flow over the ruts. I get lots better wet-weather traction, too."

• • •

The Super-Cushion is bigger and softer . . . runs on *24 pounds* of air . . . but will fit your present wheels! You'll get a *softer* ride, less wear on your car, fewer rattles and repair bills, greater safety, mileage and blowout resistance. *See your Goodyear dealer today!*



Super-Cushion by GOODYEAR

MILLIONS OF SUPER-CUSHIONS ARE NOW IN USE ON NEW AND OLDER CARS!

Super-Cushion T. M.—The Goodyear Tire & Rubber Company

Paul McC. Wiswall, '09

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONTENTS *for February, 1949* VOL. 51 No. 4

SNOWCAPPED · *Photograph by Paul R. Cunliffe* ..... THE COVER

DESCENT OF MAN · *Photograph by Taylor and Dull from Black Star* FRONTISPIECE 210

THE PRICE OF HASTE .. BY W. MACK ANGAS and WILLIAM T. HARDAKER 215

A program is proposed for passengers, aircraft manufacturers, and airline operators which aims at increasing the safety of air travel

THE CASE AGAINST THE REBEL PAINTERS .... BY PAUL MEADOWS 220

An interpretation of modern art as taken from the writings of contemporary painters

THE PROFESSION OF SOIL CONSERVATION BY EDWARD H. GRAHAM 221

Increasing concern for the conservation of the soil has led to a new profession in which engineering plays a dominant role

TAKE A NUMBER ..... BY WILLY LEY 225

Prizes for accomplishments in mathematics frequently arouse wide interest but it requires a professional mathematician to make noteworthy contributions in the field

THE TABULAR VIEW · *Contributors and Contributions* 202

MAIL RETURNS · *Letters from Review Readers* 204

THE TREND OF AFFAIRS · *News of Science and Engineering* 211

THE INSTITUTE GAZETTE · *Relating to the Massachusetts Institute of Technology* 227

Editor: B. DUDLEY

Business Manager: R. T. JOPE

Editorial Associates: PAUL COHEN; J. R. KILLIAN, JR.; WILLY LEY; F. W. NORDSIEK; J. J. ROWLANDS; D. O. WOODBURY

Editorial Staff: RUTH KING; RUTH A. PHILLIPS

Business Staff: EILEEN E. KLIMOWICZ; MADELINE R. MCCORMICK

Publisher: H. E. LOBDELL

Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 50 cents a copy. Annual subscription, $3.50; Canadian and foreign subscription, $4.00. Published for the Alumni Association of the M.I.T.: C. George Dandrow, President; H. E. Lobdell, Executive Vice-president; John A. Lunn, Orville B. Denison, Vice-presidents; Donald P. Severance, Secretary-Treasurer. Published at E. L. Hildreth and Company, Brattleboro, Vt. Editorial Office, Room 7-203, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the Post Office at Brattleboro, Vt. Copyright, 1949, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect change of address, for which both old and new addresses should be given.

Taylor and Dull from Black Star

Descent of Man

THE
TECHNOLOGY
REVIEW

Vol. 51, No. 4 February, 1949

The Trend of Affairs

Big Sleep

Most living things periodically enter a phase of dormancy, such as sleep. Human beings spend some third of their lives asleep. During sleep a depression of tissue and organ activity occurs, together with diminished muscle tone, slowed circulation and respiration, a lowered metabolic rate, and a drop in body temperature. Furthermore, during the sleeping hours, people go without food considerably longer than they ordinarily do while awake. Sleep is absolutely essential to man and to all other animals; animals may, in fact, be killed by merely keeping them awake for several days and nights in succession.

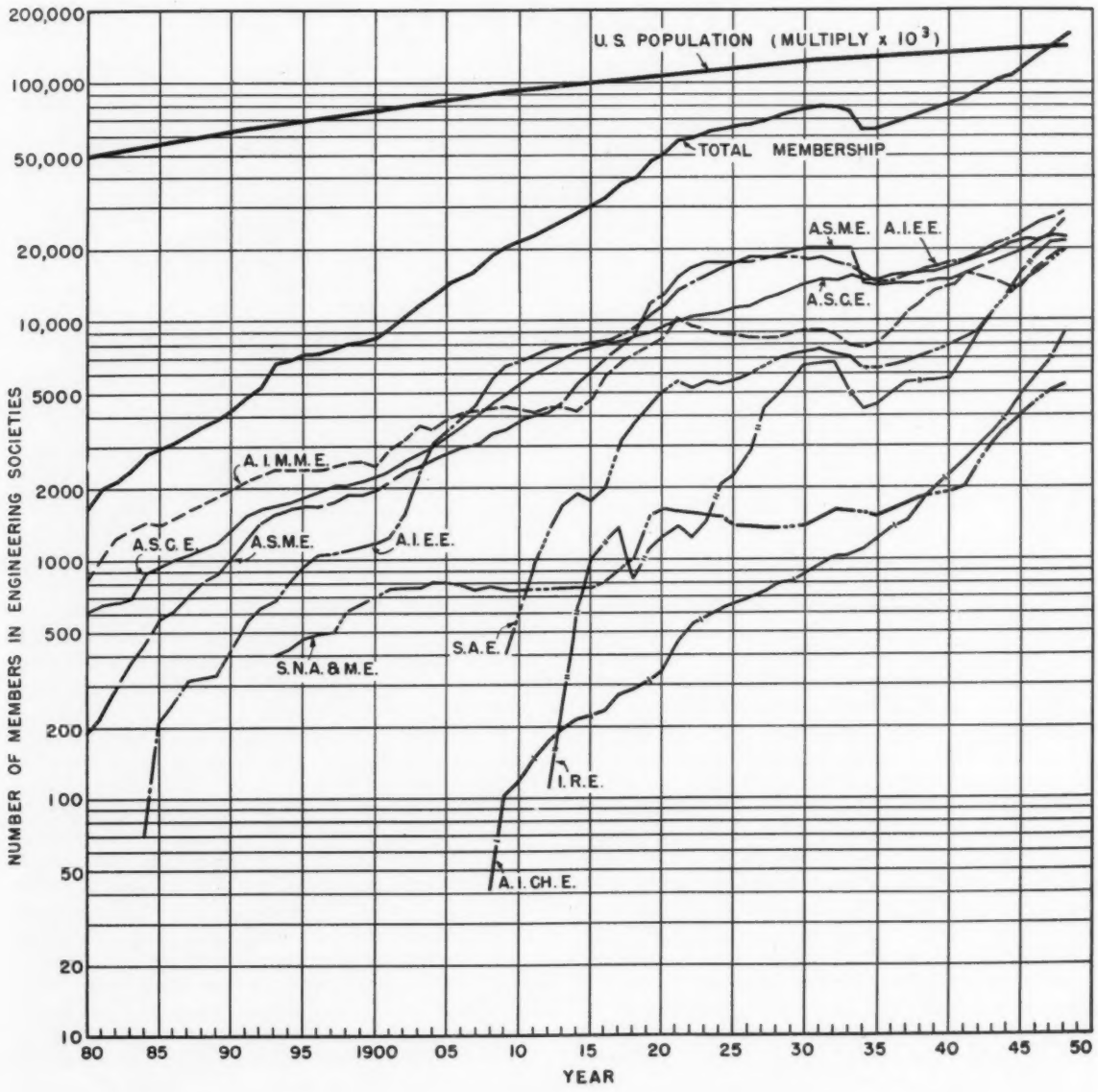
Certain mammals, and also particular species of fish and amphibians, pass the winter by hibernating. Hibernation is essentially profound and prolonged sleep; and the bodily changes occurring during hibernation are similar to those just described, but more pronounced in degree. In the tropics, some animals estivate; estivation is the seasonal converse of hibernation, in which the summer is spent in torpor.

Among higher plants a phase roughly analogous to sleep is seed formation. Seeds are primarily a means of reproduction, but they also provide a stage of dormancy to tide over periods of adverse environmental conditions, such as extreme cold or lack of water. Normally seeds germinate within a year of the time they are produced, but often are capable of retaining the spark of life for extraordinarily long periods. Thus a recently completed study of English wheat seeds, stored in sealed glass tubes, showed that after 32 years 69 per cent of the seeds were still capable of sprouting. This study was then terminated because the samples were exhausted, but the authors concluded that extrapolation of the curve of viability indicates some of the wheat seeds would still have been alive at the end of 50 years. Similar research now under way at a West Coast university has been planned to provide sufficient seeds so that survival may be observed over a period of 360 years.

A characteristic of seeds that helps them achieve long-term dormancy is low-moisture content, for seeds contain much less water than do the other tissues of the plants from which they are derived. This reduced moisture level, first of all, makes possible survival of seeds at low temperatures that otherwise would kill them. Furthermore, a low-water content appears to relate to the depressed metabolic rate necessary for survival in the dormant state; thus certain of the amphibians and fish that hibernate also undergo some degree of desiccation while dormant.

Among micro-organisms, drying is a salient basis of dormancy. In the wild, free-living state, various types of microbes are thrown into a dormant condition when their supply of moisture is cut off. Drying from the frozen state under high vacuum, a method called "lyophilizing," has recently come into wide use in laboratories for maintaining stable cultures of micro-organisms. Finally, induction of microbial dormancy by drying has now gained large-scale industrial application in the manufacture of active dry yeast for use in baking. Baking yeast is a living microbe; the familiar compressed yeast cake, an aggregation of multitudes of microscopic yeasts pressed together, has approximately the same water level as the yeast cell, namely some 60 per cent. Active dry yeast, in contrast, is living yeast in the form of dry granules with a moisture content in the neighborhood of only seven per cent. The active dry yeast is made by withdrawing water from moist yeast, by means of an exacting and delicate process, so that the yeast is thrown into a state of dormancy. Compressed yeast is highly perishable, requires refrigeration, and at best has a limited storage life, whereas active dry yeast does not need to be refrigerated and retains its activity for prolonged periods. A remarkable property of this product is its ability to revive and regain the active state within a few minutes, once it has been moistened and supplied

GROWTH OF MEMBERSHIP OF ENGINEERING SOCIETIES IN THE UNITED STATES



ABBR.		NAME	FOUNDED
———	A.S.C.E.	— AMERICAN SOCIETY OF CIVIL ENGINEERS	1852
- - - - - -	A.I.M.M.E.	— AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS	1871
———	A.S.M.E.	— AMERICAN SOCIETY OF MECHANICAL ENGINEERS	1880
——·——	A.I.E.E.	— AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS	1884
——··——	S.N.A.&M.E.	— SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS	1893
——·-·——	S.A.E.	— SOCIETY OF AUTOMOTIVE ENGINEERS	1905
——·····——	A.I.CH.E.	— AMERICAN INSTITUTE OF CHEMICAL ENGINEERS	1908
——·—·——	I.R.E.	— INSTITUTE OF RADIO ENGINEERS	1912

with fermentable sugars. Therefore, it may be prepared for use in baking almost as quickly as compressed yeast.

Some active dry yeast was made before World War II, but the war stimulated not only improvement of the product but also a vast expansion of facilities for its manufacture. Great quantities of this yeast were used by the armed services of the United States in the field, because lack of refrigeration necessitated reliance on this form of yeast, and because freshly baked bread is a staple food of fighting men. After the war, active dry yeast was returned to the civilian market. Recently, active dry yeast has entirely supplanted yeast cakes in retail stores in sections of this country. The nonperishability and prolonged stability of the dry yeast offer advantages to both the grocery dealer and the housewife.

Thus induction of dormancy by desiccation, a widespread natural phenomenon, has been brought under technological control, to make possible large-scale manufacture of a food product that was a vital factor in the good feeding of our armed forces during the war, and that now is becoming increasingly important in normal peacetime civilian food supplies.

Our Engineering Population

PERHAPS more than any other single event, World War II is responsible for public recognition of the utilitarian value of science and engineering. It is a far cry, indeed, from the guillotining of the scientific Lavoisier (because the revolutionary Coffinhal, President of the Tribunal, who tried his case, believed that "The Republic has no need for savants") to the present time when a significant part of this country's national income is devoted to research by educational institutions, industry, and government.

As a profession for which men could be trained at the college level, engineering is hardly a century old. In the address "Tomb of the Dead Languages," delivered before the Newcomen Society of England in Montreal on October 21, Karl T. Compton, chairman of the M.I.T. Corporation, traced the early history of engineering education in Europe and the United States. His address is the source of the following information:

> Already in the United States, the U.S. Military Academy had been operating really as a polytechnic school since its reorganization under Colonel Sylvanus Thayer, in 1817. Rensselaer School, which later became the Rensselaer Polytechnic Institute, had been operating since 1824 as the first professional school of civil engineering in the English-speaking world. Union College introduced civil engineering in 1845. Dartmouth founded the Chandler Scientific School in 1851, and the University of Michigan introduced instruction in engineering in 1852. . . . In 1847 the Lawrence Scientific School was founded at Harvard University by an initial gift of $50,000 from Abbott Lawrence, and simultaneously at Yale University was begun a department of Philosophy and Arts, later in 1860 to become the Sheffield Scientific School.

But although the organization of schools of science and engineering yields important data from which the beginnings of the engineering profession may be measured, the extent of engineering practice is probably more precisely gauged by the membership figures of the professional engineering societies. Such figures have been compiled for the larger of the national organizations, and are presented in graphical form on page 212. Although the data can hardly be regarded as precisely accounting for all those having a professional responsibility in engineering – because of some duplication of membership, as well as for lack of complete coverage – the composite picture does appear to provide a reliable index of the growth and importance of engineering personnel during the past seven decades. During this period, all but one of the major national engineering societies were formed.

It would be expected, of course, that the organization of a national engineering society would lag behind the development of a specific branch of physical science. Likewise it may be expected that the formation of an engineering society would correspond roughly with the rise of engineering activity in a given field. This is borne out by the dates of founding of the major societies in the United States. As changing conditions warranted, the more specialized branches of engineering sometimes came to assume such importance that new societies sprang up to meet new needs. Thus, for example, the marine, automotive, and radio engineers evolved from groups which were previously catalogued as mechanical or electrical engineers. Some of the more highly specialized groups have grown to such an extent that they threaten to exceed the membership of the older and broader group with which they might logically be affiliated. So far, however, the tail has not yet wagged the dog.

The membership curves also illustrate the relatively rapid growth of the younger engineering societies compared with that of the more venerated organizations. One explanation for this state of affairs may be that there is now a greater awareness of the benefits of engineering than existed decades ago. Another may stem from the greater support which industry has given to research for the past two or three decades. But despite widely differing rates of growth, the trend in recent years has been for the membership of the largest engineering societies to cluster in the vicinity of 25,000. In this tendency, there may be a hint that the different branches of engineering are coalescing and that the rigid, somewhat arbitrary, barriers which had been separating one branch of engineering from another may be breaking down.

The graph also shows growth of population in the United States during the past 70 years (reduced by a factor of 1,000 as indicated), along with the total membership of the societies represented in the individual curves. These two top curves show, perhaps more significantly than any other data given here, the manner in which engineering has entered into our daily lives, and also gives some hint of the important role which engineering-minded persons may be expected to play in the nation's welfare. In 1880 there was one member of a major engineering society for every 30,800 of population. By the turn of the century the proportion of engineers had grown to one for each 8,900 persons. Shortly after World War I, there was one engineer for each 2,120 persons, and the present figure is something like one out of 910 persons. If the present trend

continues, there will be one member of a major national engineering society for every 795 persons in this country by 1950. Thus, as indicated by the figures given here, more than one-tenth of one per cent of this country's population already has more than a speaking acquaintance with the slide rule – traditional symbol of our growing engineering population.

Gargantua

GIVE me a place to stand," said Archimedes, "and I will move the earth." Give the modern engineer a machine big enough to test full-sized structures and he will redesign them to meet their loads with the utmost refinement in weight and form and efficiency. Taking him at his word, the Naval Air Experimental Station, at the Philadelphia Navy Yard, has built the world's largest testing machine – a Gargantua that can pull or crush a test specimen with a load amounting to 5,000,000 pounds.

The purpose of this giant of force is to make stress-and-strain tests upon structural members of machines in full size, for the first time getting away from models. It can accommodate a specimen 30 feet long, for tension and compression, and 50 feet long in bending. It towers 47 feet above its massive concrete and steel foundations, and derives its brute force from a hydraulic ram operated at a pressure of 2,500 pounds per square inch.

At first glance, the science of aeronautics would seem the last field for supertesting machines, dealing as it does with delicate streamlining and feather-weight materials. Actually, aerodynamic forces to be met by the airplanes of tomorrow are gigantic. Hurtling with bulletlike speeds through the air, wings and fuselages may meet conditions as severe as those encountered in big guns. It is well known that, at the speed of sound, the forces produced are at almost unbelievably great magnitude. The modern design engineer's problem is to prevent the airplane from distorting and thus setting up harmonic vibrations which soon pull it apart. One of his major concerns is to achieve stiffness without excessive weight.

Naval Air Experimental Station

The control panel for the U.S. Navy's massive testing machine peers at the operator with owllike eyes.

Extreme stiffness is a characteristic not usually sought in engineering design. Most structures are intended to yield slightly. A bridge, for example, is expected to distort slightly under load, and may be quite elastic. But consider the old problem of the company of soldiers marching in step across the bridge and destroying it – or the modern one of the failure of the Tacoma Bridge in a moderate breeze. If soldiers had to keep step on a bridge it would have to be constructed so rigidly that it could not fall into harmonic vibration and wreck itself. This illustrates the present dilemma of the airplane designer.

Stiffness is a fundamental requirement in high-performance airplanes. It must be achieved by theoretical methods checked with flight tests and wind-tunnel models. Unfortunately, owing to the "mass effect," stress analysis on models is not a safe guide to actual operating stresses and their consequent strains in full-sized structures. This is the reason for the Navy's new 5,000,000-pound Gargantua, and two smaller machines which will be set up alongside it in a new structural testing laboratory in Philadelphia.

The huge machine was built by the Baldwin Locomotive Works to tolerances of a few thousandths of an inch. In principle it consists of a massive steel arch, the inner surfaces of which form vertical guides. A sensitive crosshead is fitted to slide up and down between them, its position determined by a pair of vertical screws which are nine inches in diameter. High in the machine is a fixed crosshead, and at its foot a fixed base. The motion of the sensitive crosshead downward permits the crushing of a specimen between it and the bed, or the pulling of a sample in tension between it and the upper structure. Specimens subjected to bending are carried on an extension of the bed integral with the foundations. Unlike most testing machines, the force is not applied by turning the screws, which merely adjust the space for the specimen. Instead, the whole assembly of screws and crosshead is forced downward by hydraulic pressure acting between a stationary piston in the base and a cylinder carried in a movable crosshead at the bottom.

The principal purpose of the machine is to study, by means of extremely sensitive strain gauges, the behavior of the sample as load is gradually applied. As many as 100 of these gauges can be located about the specimen to show exactly where the structural shape gives way during loading. The gauges are a Baldwin product also, and consist of tiny, bonded resistance wire arrangements which transmit continuous displacement readings to dials on a console control station on the test floor. Increments of as little as four

(Concluded on page 240)

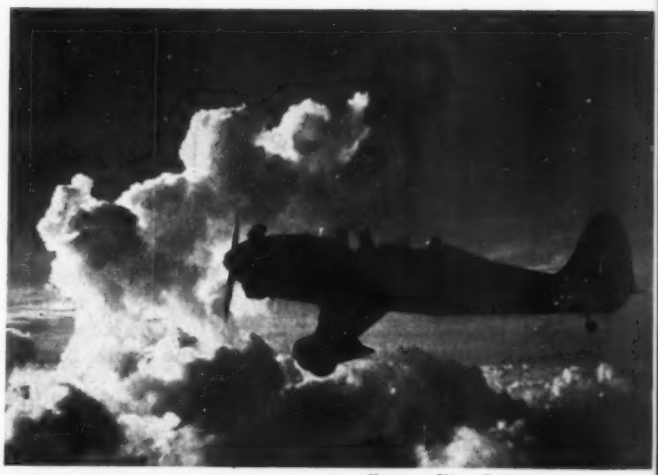
The Price of Haste

The Relatively Good Safety Record of Modern Aviation Can Be Greatly Improved with Present Knowledge and a Willingness to Make Haste Slowly

By **W. MACK ANGAS** *and* **WILLIAM T. HARDAKER**

To fly, or not to fly: that is the question. At least it's often the question uppermost in the mind of a busy American contemplating a journey of any considerable length. When air lines were first established the average American patronized them infrequently and then only when time saving was a matter of great urgency. But now everyone has friends who are habitual air travelers. To this growing and highly articulate group, air travel is so rapid and convenient that its risks should be accepted by the progressive. And the risks, they urge, are not great. For have not our domestic air lines, since 1938, been able to show passenger mileages equivalent to over 1,000 trips around the world at the equator for each passenger killed in an accident?

But a bad accident, such as that which killed 11 students returning to Yale University after their Christmas holiday, or a series of fatal crashes, such as occurred in May and June of 1947, will temporarily shake the faith of the public in the reasonable safety of air travel. Is the average traveler justified in his recurrent doubts as to the reasonable safety of commercial air transportation? If his doubts are wholly or partially justified, what should be done by government agencies, by the air lines, and the aviation industry to improve the safety of air travel? Finally, what should the traveler himself do about it? These questions are closely related, but let us, for the sake of clarity, consider them one at a time. First, then: Are our domestic air lines offering reasonably safe transportation to the traveling public?



Keystone View Company

David W. Corson from A. Devaney, Inc.

Aviators, aeronautical engineers, and other engineers brought into close contact with aviation have long shared the confirmed air traveler's scorn of the timid soul who won't fly. They have usually found themselves among those urging the reasonable safety of air travel upon the conservative, but nevertheless convincible, American traveler. They have argued the necessity of accepting the inevitable risks of using mechanisms if the advantages of life in a mechanized age are to be realized fully. They have pointed out the undeniable fact that risks of this kind are accepted by everyone who travels by land or water, and that if travel is undertaken by automobile the risk may be considerable. Now, however, a number of aviators and engineers familiar with the problems of aviation find themselves not merely sharing the recurrent doubts of the public as to reasonable safety of air travel; they find themselves reaching the conclusion that improvement in the safety of air transportation has not been commensurate with technological de-

Official U.S. Navy Photograph

Two operators of the Ground Control Approach system instruct the airplane pilot, by radio, as to safe landing in overcast weather.

velopments in aviation. They also find themselves reaching the conclusion that safety on our air lines has been sacrificed in an attempt to anticipate hastily today the achievements that may be realized safely tomorrow.

That there has been little improvement in the safety of our domestic air lines during the past 10 years is undeniable. Here are the official figures of the Civil Aeronautics Board (estimated for 1948) which include trunk, feeder, and territorial carriers:

Years	*Passenger Miles Flown*	*Passenger Fatalities*	*Passenger Miles Flown Per Passenger Fatality*
1939	755,347,796	9	83,927,533
1940	1,158,994,132	35	33,114,118
1941	1,507,238,053	35	43,063,944
1942	1,500,762,963	55	27,286,599
1943	1,670,934,726	22	75,951,578
1944	2,213,251,851	48	46,109,413
1945	3,408,289,906	76	44,845,920
1946	6,068,317,417	75	80,910,899
1947	6,313,220,664	199	31,724,727
1948	6,000,000,000	83	72,289,157
For 10 Years	30,596,357,508	637	48,031,948

The figures for Passenger Miles Flown Per Passenger Fatality, therefore, show the year 1939 to have been the safest one in which to travel by American domestic air lines! And the record of the year 1947 was next to the worst of the last 10! Too much importance should not, of course, be given to the figures for a single bad year. Let us, therefore, compute and examine the figures for the first three and last three years of the decade. Here they are:

Years	*Passenger Miles Flown*	*Passenger Fatalities*	*Passenger Miles Flown Per Passenger Fatality*
1939, 1940, 1941	3,421,579,981	79	43,311,139
1946, 1947, 1948	18,381,538,081	357	51,488,902

The figures for the last three years of the decade are therefore distinctly better than for the first three years, and slightly better than the average figure for the entire 10-year period. It is a disappointing showing, however, for 10 years in which great technological developments in aviation were unquestionably made. What is wrong? Will a review of the three crashes which prompted the appointment of President Truman's Air Safety Board throw light on the trouble?

The first of these occurred on May 29, 1947. United Air Lines Flight Number 521 was about to leave LaGuardia Field for Cleveland. The airplane, a DC-4, had taken aboard 44 passengers and taxied to the north end of runway 18, where it stood while the pilot warmed up its four motors, tested them, and awaited final clearance. There was a strong but pleasant southerly breeze. To the northwest and west the skyline of New York was being rapidly obscured by the murk of an approaching thunder squall.

The scene in the cabin may be imagined. Seasoned air travelers confidently fastened their safety belts while the uninitiated fumbled nervously with theirs and were finally helped to fasten them. Desultory conversations commenced, but were soon ended by the roar of the motors as the plane moved forward onto the runway. The volume of sound again increased as the take-off run started. Faster and faster the dimly seen earth rushed past the windows. Suddenly the confident roar of the four motors choked to a coughing sputter, passengers were thrown violently forward against their safety belts and the tires shrieked in protest as they slid on the pavement. It was now the experienced air travelers who were badly frightened, for the pilot was evidently trying to halt the take-off. But the airplane continued toward the end of the runway, swaying and yawing in its now obviously uncontrolled rush. As it went through the fence at the end of the field and ricocheted across the depressed pavements of Grand Central Motor Parkway, there was a rending crash, accompanied by screams, and the lights of cars glared for an instant into the cabin windows. Then with a final shuddering crash the doomed air liner came to rest. A moment later it was enveloped in flame. Of the 44 killed or fatally injured in the resulting holocaust, the fortunate were those unconscious when reached by the fire.

For some little time the hypothesis was widely accepted that the accident was caused by a sudden wind shift occurring just as the airplane started its take-off. Such wind shifts are by no means uncommon at the onset of thunder squalls. This one, according to early investigators of the accident, suddenly changed a head wind, which favored a prompt take-off, into a cross wind in which the heavily loaded plane couldn't get off the ground within the 3,500-foot length of runway 18.

Investigation of the cause of the crash by Civil Aeronautics Administration officials did not, however, substantiate the wind-shift theory. Evidence was found that the pilot, an experienced man and one of the few survivors of the accident, had failed to release the gust-lock with which the rudder and other control surfaces of a large airplane are immobilized when it is on the ground. Investigators of the Civil Aeronautics Administration also found that the much discussed wind shift occurred before, and not after, the airplane started its abortive take-off. But acceptance of the gust-lock theory as the cause of this accident does not explain the almost fantastically incredible fact that at the principal airport of the world's largest city, a heavily loaded, four-motor transport plane was permitted to attempt a cross wind take-off in the early phases of a heavy thunder squall from a 3,500-foot runway! During World War II, the Navy's Seabees built runways 5,000, 6,000 and even 7,500 feet long on Pacific Islands for four-motor bombers and transports! Is not the traveling public, in time of peace, entitled to safety factors equivalent to those provided military personnel in time of war?

To guard against accidents caused by unforeseen contingencies, aircraft are designed and built with adequate safety factors. Should not the fields from which they operate provide similar protection to the occupants of planes? And should the shortness of runway 18 at La Guardia Field be completely eliminated as a factor provocative of an accident in which 44 lives were lost? Why was not the plane ordered to another and longer runway if the wind shift occurred before the plane commenced its fatal attempt to take off? Was not a serious risk being run merely to save time? Why did the pilot forget to release the gust lock? Did not the knowledge that he faced a risky take-off under adverse conditions, from a runway of questionable length, place him under a strain such as is provocative of oversights? Were he and the copilot given an adequate "check-off list" to help them insure the proper setting of the numerous controls of a big transport plane before attempting a take-off or landing? It is significant that runway 18 at La Guardia Airport was closed to four-motor transport planes shortly after the accident. It is also significant, and disquieting, that air lines protested the order, probably because it slows down departures by increasing taxiing distances and decreases the number of runways available for simultaneous take-offs.

Two days after the crash at La Guardia, representatives of the Civil Aeronautics Board were returning to Washington from New York where they had been investigating the cause of the accident. As they approached the Susquehanna River in their DC-3, an Eastern Airliner overtook and passed beneath them on its way toward Miami. More or less idly they watched the steady and majestic progress of the DC-4. Suddenly it nosed down sharply. Momentarily expecting it to level off and resume its southward flight, they were horrified to see it go into a vertical dive. This then became the beginning of an outside loop which terminated in a burst of flame and pall of smoke from the woods near Port Deposit. Obviously there could be no survivors.

The cause of this crash will probably never be known definitely. Perhaps it should be classified as a type of accident which will occasionally happen in the air, at sea, or on land as long as men must entrust their lives to the proper functioning of mechanisms. Speculation as to the possible cause of such an accident, may, however, be profitable and productive of improved safety measures. A reasonable hypothesis as to the cause of this crash may in fact be based on events leading to an alarming near-accident which occurred a few months later near El Paso.

An American Air Lines DC-4 was flying in good weather at an altitude of about 8,000 feet. A check pilot, riding behind the pilots who were actually flying the plane, surreptitiously fastened the gust lock, apparently to see what would happen. The airplane began a gradual but steady climb which the puzzled pilot sought to correct by adjusting the trim tabs to bring the nose down. Then the prankster, or perhaps it would be more charitable to say "experimenter," suddenly released the gust lock. The plane immediately went into a dive. Terrified passengers were thrown from their seats as were the first pilot and check pilot. Fortunately, however, the copilot was securely strapped in, and was thus able to regain control of the plane and land it safely.

It is almost incredible that a similar prank caused the Port Deposit crash. It is, however, entirely credible that a sudden failure of the automatic gyro pilot, or an unanticipated local air disturbance, may have sent the airplane into a violent dive and that the pilot and copilot, if not securely strapped into their seats, were unable to regain control in time to prevent a crash. Regulations requiring all occupants of the control cockpit of a transport plane to keep their safety belts fastened at all times should be rigidly enforced. This is the lesson of the Port Deposit crash when coupled with the El Paso incident, even if it is only based on speculation as to the actual cause of the crash.

One may, however, do more than speculate as to the cause of the next major air-line accident. Hardly had the difficult and grisly task of assembling and identifying the 53 charred and dismembered bodies at Port Deposit been completed when tragedy again struck the air lines. On June 13, a Pennsylvania Central air liner from Chicago failed to arrive at Washington's National Airport though it had been in communication with Washington as to methods of approach. It was raining, the ceiling was low, and airplanes were flying, in general, on instruments. At the airport, friends and relatives waiting to greet the air-liner's passengers became at first uneasy, and then fearful, as minutes and hours passed without news of the plane having landed safely elsewhere. But the fate of the plane, its 47 passengers and crew of three did not long remain a mystery.

Next morning the occupants of a searching airplane saw, near the top of an eastern outpost of the Blue Ridge, a patch of fire-scarred vegetation surrounding the scattered and torn wreckage of the missing air liner. The improbability of anyone having survived the crash was confirmed when a rescue party reached the wreck. The cause of the crash was not difficult to determine.

The airplane had been approaching Washington on instruments at an assigned altitude well above the tops of mountains over which it had passed. This altitude would have brought it into the "stack" of airplanes "holding" in the overcast above Washington. It would then have been required to "hold," that is, to fly within a prescribed area and at an assigned altitude, until given clearance to descend, make its approach to the field, and land. To avoid the delay incident to this procedure, a delay always exasperating to passengers, the pilot had requested permission to descend before reaching the immediate vicinity of Washington and make his approach to the airport under the overcast on contact flight rules. This permission was granted by the airway traffic controller in Washington, provided visual contact with the ground could be maintained at 2,500 feet from Arcola. The airplane crashed into a 1,689-foot ridge 150 feet below its summit, apparently while descending. The cost of trying to save a few minutes, or at the most a couple of hours, was 50 lives. The procedure was one which could, in all probability, have been followed safely by an airplane carrying radar equipment of a type fully developed but not yet adopted as standard equipment on airliners.

A Program of Rational Action

The crash of this plane brought the number of lives lost on scheduled commercial flights of domestic air lines in the United States in May and June of 1947 to a total of 147. Of this number, 94 lives were lost in accidents which may fairly be classed as preventable. They were lost in accidents attributable directly or indirectly to some form of haste. No figure, no matter how impressive, as to the number of passenger miles flown in safety during the same period should be considered as an offset against this tragic waste of human life. Truly, in May and June of 1947, the price of haste was high. What has been done to reduce it? What is being done? What should be done?

Undoubtedly much has been accomplished by governmental agencies. There has been a general and laudable tightening of flight regulations, largely no doubt through the efforts of the President's Safety Board. The rules regarding the closely interrelated subjects of airplane loadings, runway lengths, take-offs, and landings have, for example, been reviewed and revised. Standardized check-off lists have been adopted to facilitate thorough preparation for take-offs and landings, which are the more risky phases of normal flights. Regulations covering minimum altitudes over mountainous terrain in instrument weather have also been revised in the interest of safety. These are things which could be done immediately without considerable outlay. It is gratifying to know that they have been done and that they are making commercial air transportation safer today than it was two years ago. But they are measures which do not interfere seriously with any well-established practice of air travelers, and they are therefore measures which were unlikely to encounter strong opposition. Our record has been less impressive when we consider our failure to adopt safety measures which would be unpopular with the traveling public and the air lines.

One such unpopular measure which probably should be adopted is the prohibition of smoking in planes. Do we, the authors, smoke in planes? Assuredly we do, and we'll continue to do so as long as smoking is permitted and others do it. But that doesn't make it safe! Aircraft carrying such highly volatile fuels as gasoline are fundamentally unsafe places in which to smoke. What the effect of a strictly applied "no smoking" regulation might be on the volume of business done by commercial air lines is difficult to estimate. There is no doubt, however, that such a regulation would make air travel safer. Our forefathers dreaded, as we still dread, fire at sea. But fire at sea, terrible as it can be, does not always threaten swift, immediate, and almost inevitable death to all hands, as does fire in the air. How many crashes are due to fires occurring on aircraft in flight will never be known, as a high percentage of such fires must terminate in crashes that leave no survivors, and only a mass of charred wreckage from which little can be deduced.

But our failure to prohibit smoking in airplanes using gasoline as fuel is not our only failure to adopt unpopular safety measures. Clearance authorities should be more chary about giving clearances to airplanes headed for destinations at which weather conditions will permit landings only under unfavorable circumstances. The "stacking" of airplanes over a busy airport in instrument weather isn't an overly safe procedure and sooner or later we're going to have a collision in a "stack." In fact, such an accident occurred last year on July 4 when a Royal Air Force military transport plane collided with a Scandanavian Airways four-motor air liner over Northolt Airport near London. The 25 passengers of the air liner, its crew of seven, and the six occupants of the military transport were, of course, killed. It is inevitable that the stacking of planes in the vicinity of a big airport will occasionally be necessitated by the sudden onset of instrument weather, but the procedure is one which should be avoided, even at the cost of serious interference with scheduled air-line operations. This is a safety measure which should be taken before, not after, all the passengers of two big transport planes perish in what may well be commercial aviation's worst disaster in lives and property lost.

A possible solution of this problem may be the adoption of a block-signal system on our airways. Such a system has been proposed and is analogous to the familiar railroad signal system from which it takes its name. It would provide for horizontal spacing of airplanes on the same route in addition to the vertical spacing now provided. The system cannot, however, be placed in operation prior to the extensive installation of equipment not yet manufactured. It will, therefore, probably be at least five years before such a block-signal system could be placed in service, even if funds for the necessary installations were made available immediately.

Of course the danger of landing in bad weather will be greatly reduced when the Instrument Landing System and Ground Control Approach, much publicized as "ILS" and "GCA," come into common use. At an airport equipped with ILS the pilot of an airplane carrying present-day, standard radio and flight instru-

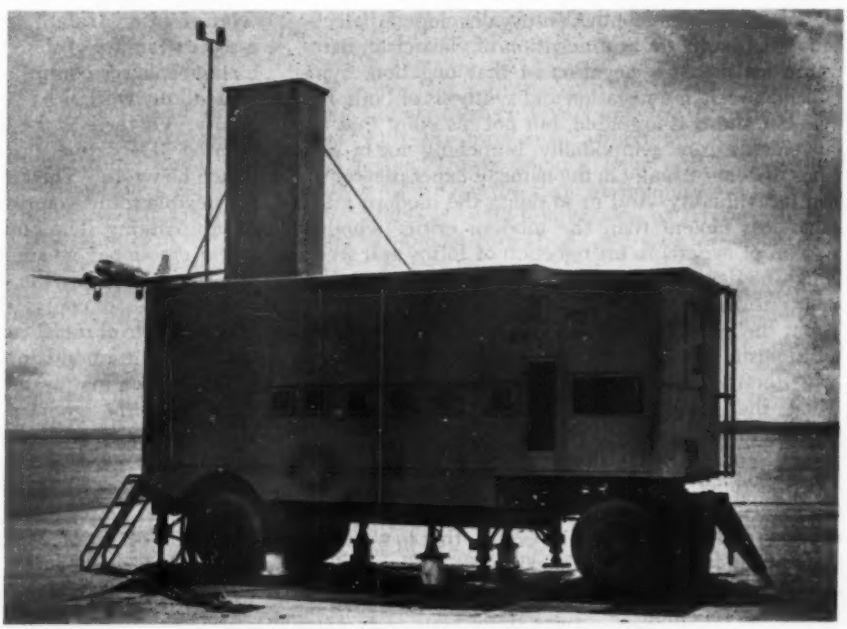
ments, plus a relatively simple and light glide-path receiver, can approach a designated runway and land on it in weather so thick that a landing by traditional methods would be impossible. In using the system, the pilot is guided by instruments which he himself sees and the readings of which he interprets. At an airport equipped with GCA a pilot in an airplane carrying standard flight and radio instruments, without additional equipment, may similarly make a landing in thick weather. In landing by GCA the pilot maneuvers in accordance with instructions obtained by radio from a ground crew which determines the position of the airplane during its approach by means of highly specialized radar instruments. Both ILS and GCA have stood the test of actual use over extended periods by the Army, Navy, and Air Force. Supplemented by improved approach lights, and by surveillance radar enabling the flight tower crew to locate planes in an impenetrable overcast, ILS and GCA will do much to solve the problem of getting airplanes safely onto the ground in instrument weather.

But neither ILS nor GCA can be effective until installed, and though a number of installations have been made, an enormous amount of work remains to be done. To be specific, 98 instrument-landing systems were authorized in appropriations prior to the fiscal year 1948. To carry on the work in that year, it was recommended to Congress that 184 units of four types — improved approach lights, GCA, surveillance radar, and ILS — be installed at an estimated cost of $13,428,000. This was reduced by the House of Representatives to $5,930,000, which would cover the cost of about 78 units, and by the Senate to $571,706, which would cover the cost of only a meager fraction of what was needed. Fortunately, however, appropriations for the fiscal year 1949 are more generous and provide funds which will enable the Civil Aeronautics Administration to establish 10 additional high-intensity approach lights, 40 instrument-landing systems, 17 airport surveillance radar installations, and 7 GCA installations within the continental limits of the United States. These are, of course, steps in the right direction, but they fall far short of furnishing everything considered necessary by those striving for maximum safety of our airways. If we are to have safer air travel, we will have to pay for it.

The installation of such aids to aerial navigation by the Federal Government will by no means solve the entire problem. State and local authorities face a far heavier task; the task of providing the auxiliary airports required to realize fully the possibility of reasonably safe all-weather air transportation promised by such systems as ILS and GCA. For even the most enthusiastic admirers of these systems do not claim that landings can be made by them in bad weather with anything like the rapidity possible in good weather under contact flight rules. A large and well-equipped airport can easily bring in an airplane a minute under the latter conditions, while the best it can hope to do in bad weather with ILS or GCA is about one plane every four minutes. If a port is scheduled to handle 60 planes an hour and the onset of instrument weather suddenly reduces its capacity to 15 planes, what are the other 45 airplanes going to do? If the conditions producing low visibility are temporary, such as a shower, airplanes may be held overhead or at designated holding points until conditions improve. If, however, the instrument weather promises to be of long duration, most of the airplanes must obviously be diverted to auxiliary fields at which they may descend by instrument let down, or to alternate fields still in an area of good weather. The provision of the necessary auxiliary airports to make such an arrangement possible at our more important cities and air terminals is a very large undertaking. It is not, however, an undertaking beyond the capacity of the American people.

So much then for the responsibilities of governmental agencies — Federal, state, and local — in giving

(*Continued on page 238*)



The danger of landing airplanes in bad weather will be greatly reduced when the Instrument Landing and Ground Control Approach systems come into common use. In landing by GCA, the pilot maneuvers in accordance with instructions from a ground crew which determines the position of the airplane during its approach by means of highly specialized radar equipment. In the installation shown, the GCA equipment is housed in a mobile truck.

U.S. Navy Photograph

THE CASE AGAINST
The Rebel Painters

When Viewed in the Light of Their Own Writings the Work of the Modern Painter Often Takes on New Significance

By PAUL MEADOWS

THE modern artist is a much maligned person. His critics range from the editorial organs of the Communist party to the President of the United States, and include professional artists and those without artistic qualifications. The complaints vary from failure to understand what it is all about to severe aesthetic strictures on experimental technique; charges of obscurantism and sensationalism mingle freely. No form of art is free from indictment, neither literary nor plastic, nor graphic. And the bill of particulars is by now a venerable document.

For the modern artist was calumniated from the start – whenever that was. The critics of the 'Forties hew to the line of the critics of the 'Nineties. Of course, what was *avant-garde* (and therefore suspect) in the *fin de siècle* days of the Nineteenth Century has for a generation now been academic and even popular art. Yet the stream of protest flows noisily on its way, and seems to be practically unstemmed.

The reasons are not hard to find. Most modern art movements have grown as revolts against existing or prevailing art. There is a pronounced rebel theme in modern art. Thus, the literary critic, Edmund Wilson, sought to show, in his *Axel's Castle*,[1] that the literary schools of the Nineteenth Century developed dialectically: Romanticism as a negation of classicism, naturalism-realism as a negation of that negation. Symbolism, he felt, is a negation and synthesis of both. His dialectic thesis is arguable, but not his point that art movements grow sympodially, branching out of previous dissents, usually in the name of experimentalism and individuality. And in so doing the modern artist is no less violent than the modern critic (whether layman or expert) in his rejection of forms and styles which he does not care to use. If artist attacks artist, their critics can at least plead precedent.

But the curse of obscurantism or decadence or exhibitionism or infantilism falls as easily from the lips of a Rotarian Babbitt as from an initiated aesthete. What, then, is bothering both the critical observer and the critical artist?

One ventures to say that it is a case of shock. The artist, as rebel, is in revolt against the past in art and the present in culture, both of which shock him. And the form and technique of his revolt – that *to* which he is revolting – succeed in shocking his audience. The case against the modern artist is the style and direction of his rebellion.

Consider the case against the rebel painters; consider it especially in terms of their own words, not their paintings. For what they say about their work continues to be even more a cause of shock to the modern observer than their paintings. Documentation is abundant: the painter often is as facile with his pen as with his brush.

Examine, for example, the comments of one, Francis Picabia, writing in *The Little Review*[2] in the year 1922. "*Le Salon d'Automne* will open in a few days. May I offer a word of advice to the members of the jury: to refuse pitilessly all that they like and accept only that which horrifies them." You see that we come to the point immediately. The unacceptable, the horrible, must become the acceptable. Dali would agree, emphatically; and Grosz.

The subject matter of the rebel painters is, more often than not, unpredictable, private horror, victim of impulses unknown either to artist or observer. Writes William Baziotes:[3] "I keep working on my canvas until I think it is finished. The subject matter may be revealed to me in the middle of the work, or I may not recognize it until a long time afterward." Or again, Boris Margo,[4] speaking of his painting "Nature of an Unfathomable World": "The painting is a pure fantasy of shapes and images which undergo metamorphoses controlled by forces of light. In this, as in all my work, I had no desire to achieve absolute clarity." Or there is the instance of Leon Kelly,[5] who painted "Departure through the Umbrellas," about which he wrote: "The actors or subjects in the picture are flexible forms complying suitably to the evolution of my painting. The umbrella shape . . . has a dramatic emotional meaning to me. The insect in the painting represents the ego." He did not say whose.

Sometimes, of course, the rebellious modern painter plays the role of social commentator. Thus, Marinetti,[6] leader of the quondam futurists, declared in his famous London manifesto: "We are against the universal right of the ignorant to discuss and decide upon all questions of art." He asked his futurists "to cultivate the hatred of intelligence and to reawaken that divine intuition which is the characteristic gift of the Latin races." Soffici,[7] one of the group, inveighed against "mob interference in matters of art," in place of which he called for "enthusiastic recognition of intellectual superiority."

(*Continued on page 242*)

J. W. McManigal from Gendreau

THE PROFESSION OF Soil Conservation

Engineering and Agriculture Meet on Common Ground in Striving for More Planet and Less Plunder

By **EDWARD H. GRAHAM**

Last year, Ira N. Gabrielson, President of Wildlife Management Institute, defined conservation as "the wise use of our natural resources." He pointed out that conservation is not the locking up of resources for some distant future use. Conservation is the matter of using wisely, and with care, the resources with which this land was originally endowed, or what remains of them. One of these natural resources, the soil—and its conservation—is the subject of this present article.

In order to consider the subject of soil conservation, either in general or in its specialized engineering aspects, it is first necessary to examine the nature and composition of soil itself.

The Nature of Soil

In a general sense, soil may be defined as the weathered and otherwise modified outermost layer of the earth's crust. It is not the same everywhere. It varies from one climatic region to another. It varies with the type of vegetation. Soils developed under forests have thinner surface layers and less organic matter than soils of grasslands, which are usually deep and fertile. Desert regions have poorly developed soils. Soils are not the same on uplands and river bottoms. Soils vary with topography, with type of underlying geological formation, and with other environmental factors.

Soil is more than disintegrated rock. It has definite structure, and a distinct form. Soils are developed over long periods of time, and they are different near the surface from what they are at some depth below. Soil usually consists of horizontal layers called the *A*, *B*, and *C* horizons, in order of depth. The *A* horizon is popularly called topsoil. The *B* horizon is subsoil. The *C* horizon is weathered but otherwise little changed parent material, below which is the underlying rock. Compared to the diameter of the earth, or even to the thickness of the geological formations composing the outermost layers of the earth's crust, soil forms an exceedingly thin veneer on our globe. It varies from a few inches in thickness to a few feet.

The layers or horizons of soil form a profile which results from the interaction of physical, chemical, and biological influences. Physical disintegration and chemical decomposition of mineral constituents and the recombination of the resulting substances contribute character to a soil profile. Just as important are the plant and animal components. Organic residues from plants and animals contribute to the character of soils. Nonorganic substances and organic materials together are constantly being redistributed as a consequence of water movement, leaching, and the activities of soil organisms.

Soil is far from being an inert medium. Bacteria, minute plants and tiny animals, fungi, molds, insects, roots of grasses, herbs, shrubs, and trees, and vertebrate animals live in the soil. A single particle of surface loam may contain 60,000,000 bacteria. An acre of Maryland meadow supports 13,500,000 invertebrates at no greater depth than "a bird can easily scratch." Soils of the Russian steppe are known to support as many as 415,000 ant nests per square kilometer. Ninety-five per cent of all insects invade the soil at some time. Earthworms and burrowing rodents cultivate, fertilize, and help to form the soil.

Soil, therefore, is a highly complex, rather delicate, medium that has resulted from a long history of slow development. It is a complex and intricate natural substance with a unique form and character.

Soil Erosion

Some kind of soil erosion has probably occurred since the first rain. Such normal erosion is a process as old as geological history, and in most regions of the world it is an imperceptibly slow, though persistent, action. It is usually so gradual that, as the upper portions of the soil profile are removed by wind or water, soil-building processes compensate for their removal by developing the lower portions of the profile. The result is the downward progress of the entire profile, and, geologically, eventual leveling of the landscape, or peneplanation.

Acme

It is of interest to engineers that Thomas Jefferson encouraged contour cultivation, which he called "horizontal plowing."

With the development of agriculture, man became an environmental factor of major importance. His use of fire and cultivation of the soil accelerated erosion. One of the first effects of man-induced erosion is the removal of the uppermost or *A* horizon at a rate faster than formative processes can replace it. This means loss of the richest and most productive portion of the soil first, for topsoil contains more organic matter and available plant nutrients than portions of the soil beneath it.

The loss of topsoil under conditions of use is tremendous. In an Oklahoma field where cotton was grown continuously on a 7.7 per cent slope, experiments showed that Vernon fine sandy loam lost 24 tons of soil per acre per year. Shelby silt loam in Missouri annually lost 68 tons of soil from an 8 per cent slope where corn was grown year after year. On a 16 per cent slope under continuous corn, Clinton silt loam in Wisconsin lost 88 tons annually. In each of the cases cited, the annual rainfall was between 30 and 35 inches.

The extent of accelerated soil erosion is no less striking than its intensity. In the United States there are 1,903,000,000 acres of land. Slightly more than half this acreage is in farms and ranches. Man-induced erosion has severely damaged 282,000,000 acres of land. This is an area larger than that of Texas and California combined. Another 775,000,000 acres have been eroded to some extent. Thus, more than half our total land area is affected by man-induced erosion. About 460,000,000 acres of land in the United States are suitable for cultivation. About 100,000,000 acres of former cropland have been badly damaged by erosion. Erosion continues in the United States – to the extent that some 500,000 acres each year are made unfit for immediate practical cultivation.

On many lands, where little loss of soil actually takes place, soil depletion may nevertheless occur. This is true even on comparatively level areas if the land is improperly used. When chemical elements necessary to health and welfare are removed from the soil by cultivation, leaching, or other activity associated with use of the land, they are likely to be absent from the crops grown on those soils. All too little is known of this subject, but during World War II many young men from agricultural areas were declared unfit for service because of various deficiency diseases. Such diseases seem to be on the increase.

Public Interest in Erosion Control

It should be noted that erosion is just as serious, or even more advanced, in other parts of the world. In China, India, the Near East, Greece, North Africa, Italy, Spain, South Africa, Russia, Australia, New Zealand, and Central and South America, as well as in our own country, soil loss through accelerated, man-induced erosion is widespread and serious. It is becoming the concern of nations almost everywhere.

It has been obvious in the United States, since Colonial times, that we needed to protect the soil. In 1769, George Washington experimented in his Mount Vernon fields to determine "whether the land was not preserved more by harrowing than by lying in furrows." By the close of that century, much of the once produc-

Harold M. Lambert

With the development of agriculture, man became an environmental factor of major importance. His use of . . . cultivation of the soil accelerated erosion.

tive land along the Potomoc had become practically worthless. In 1817, Thomas Jefferson wrote that "fields were no sooner cleared than washed." It is of interest to engineers that Jefferson encouraged contour cultivation, which he called "horizontal plowing."

Westward expansion to more fertile prairie lands minimized the need for attending to the care of the land. Land could be had for the taking, and in 1862 the Homestead Act encouraged people to stake claims on free land, with almost complete disregard of the capacity of the land to support them. Throughout the history of the nation there were voices raised in defense of the land, but they were weakly heard, if at all. Since the turn of the present century, however, there has been more and more interest in controlling erosion and in using the land well.

Today most states conduct research and education in soil conservation. All states support locally developed programs of soil conservation conducted by farmers and ranchers. There is a National Association of Soil Conservation Districts representing these local groups. Urban interest is expressed in another national organization, Friends of the Land. Within the Federal government there is a bureau devoted exclusively to this work – the Soil Conservation Service – and numerous other bureaus consider it in connection with their normal activities. There is today a professional society of soil conservationists – The Soil Conservation Society of America. Some 75 colleges and universities offer courses in soil conservation. Thirteen schools offer majors in the subject. The subject is receiving more and more attention on the part of the general public.

Attacking the Problem

All of this interest has resulted in the development of activity in a new and specialized field. There has developed, within the past 15 years, the profession of soil conservation.

Before it is possible to control erosion, it is first necessary to understand the process. Early soil surveys pointed to the problem. By the 1920's some of the states began to publish results of experimental work dealing with surface runoff and factors influencing soil erosion. In 1928 the United States House of Representatives provided for investigations into the causes of erosion, the possibility of increasing absorption of rainfall by the soil, and the development of means for preserving the soil, controlling destructive erosion and conserving rainfall.

As a result of this and subsequent Congressional action, 10 erosion-experiment stations were established on important types of farm land throughout the United States. Research in soil conservation is being actively pursued by the Federal government, the State Experiment Stations, and various colleges and universities. In many respects it is still a new field of study, especially in its practical or applied aspects, and engineering looms large in many of the problems to be solved. Water percolation, infiltration, and runoff are highly important phases of erosion, and they are primarily, although not exclusively, physical in nature.

As a result of the increased national interest in soil conservation and erosion control, a national program of erosion control was inaugurated in 1933. This took permanent form on April 27, 1935 in the passage of the Soil Conservation Act. The preamble to this act reads as follows:

> It is hereby recognized that the wastage of soil and moisture resources on farm, grazing and forest lands of the Nation, resulting from soil erosion, is a menace to the national welfare and that it is hereby declared to be the policy of Congress to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands and relieve unemployment.

This was an eventful step, and it started an action program on the land that is without parallel in American history. By 1937 the states began passage of soil conservation district laws. Each state now has such a law on its books, and 1,940 districts have been organized, embracing more than a billion acres of land. More than three-fourths of all the farms and ranches in the United States are now within the boundaries of such districts, which are still forming at the rate of 15 to 20 per month. Within a district, local farmers or ranchers develop a program of soil and water conservation, in the application of which technical assistance is made available from local, state, and Federal agencies. The record of these soil conservation districts is an amazing illustration of democracy in action and the practical application of scientific knowledge to human problems and their solution.

Let us now look at two or three of the fundamental concepts on which actual programs of soil conservation are based. As already noted, soils differ from place to place. They vary with slope and other natural conditions. Furthermore, they have been influenced tremendously by the use which man has made of them.

Land Capability Classification

If we are to control erosion and accomplish soil conservation, it is necessary, first of all, to have at hand an analysis of land conditions as an index of the kind of use that can be made of the land. Such an analysis should provide a classification of land on a scale large enough that it differentiates parcels of land within an individual farm or ranch. To arrive at such a classification, we delineate, on an aerial photograph, the kind of soil, slope of the land, kind and degree of erosion damage, overflow hazards, wet areas, and such features as field and pasture boundaries, houses, roads, and streams. This map is made on a scale of four or eight inches to the mile.

When these data are mapped, and considered in the light of the local climate, they form a basis for working out a classification of land according to its capacity for use. Definite combinations of soil, slope, and erosion are assigned to a capability class. As a result of considerable experience, it has proved most practicable to group types of land into eight classes, ranging from the best and most easily cultivated land (Class I) to land that is not suitable for cultivation, grazing, or forestry, but is valuable primarily for wild life, recreation, and watershed protection (Class VIII).

The Land Capability Classification scheme is outlined briefly in eight categories as given in the table at the top of the next column.

The general descriptions of the land classes may be amplified and refined, within the basic concept, to depict more accurately the specific kinds of land in each locality. Moreover, the land capability classes are too broad for detailed recommendations or specific treatments. It is necessary to establish treatment units (sometimes called use-management groups) within each land capability class. A treatment unit includes a specified range of soil properties, slopes, stages of erosion, and other land factors. Recommendations for utilization and treatment are then based upon the unit within the capability class.

Brief General Descriptions of Land Capability Classes

Class	Land Use
	SUITED FOR CULTIVATION
I	Very good land; few or no limitations in type of use; can be cultivated safely with ordinary good farming methods.
II	Good land; moderate limitations or hazards; can be cultivated safely with simple easily applied or moderate conservation practices.
III	Moderately good land; severe limitations or hazards; can be cultivated safely with intensive treatments.
IV	Fairly good land; very severe limitations or hazards; suited for some forms of limited cultivation or for limited choice of crops.
	NOT SUITED FOR CULTIVATION BUT SUITED FOR GRAZING OR FORESTRY
V	Not more than slight limitations, except those imposed by the needs of desirable grass or tree vegetation.
VI	Moderate limitations.
VII	Severe limitations.
	NOT SUITED FOR CULTIVATION, GRAZING, OR FORESTRY
VIII	Suited for wild life or recreational use, or for watershed protection purposes.

The land capability class determines the most intensive use to which a parcel of land can be subjected without deterioration of that land. For each capability class, particular land-use practices are applicable. On Class I land, for example, practices such as the use of fertilizers and simple crop rotations may be sufficient to keep the land productive and prevent it from eroding. On Class III land, however, carefully designed terraces and water-disposal systems, in combination with strip cropping, long rotations, and other conservation practices, may be essential to hold the soil in its proper place.

The Co-ordinated Approach

The soil conservationist must deal with land-use practices applicable to all classes of land – cropland, pasture, range, woodland and wild-life land under various conditions of use. Because of this, soil conservation becomes the meeting ground of many fields. In this activity, engineering, biology, forestry, agronomy, economics, and many other spheres of human endeavor are focused upon one problem – soil erosion. The need for co-ordinated effort was expressed in 1934 by the chief of the Soil Conservation Service, Hugh H. Bennett, when modern soil conservation was still very new. The principle he declared is one of the outstanding characteristics of this new profession of soil conservation. He said:

Here is the first attempt in the history of the country to put through large-scale, comprehensive erosion and flood-control projects, applying to complete watersheds from the very crest of the ridges down across the slopes to the banks of streams and thence to their mouths. These are not engineering projects or forestry projects or cropping projects

(*Continued on page 246*)

Take a Number

Sometimes the Stimulation of Monetary Rewards Brings Forth Unexpected Results in Mathematics but Seldom Is That Science Advanced as a Result

By WILLY LEY

MOST scientific work is undertaken and accomplished for the sake of knowledge, the love of truth, and the glory of discovery. Nevertheless it is by no means detrimental to the progress of science that there is such a thing as the Nobel Prize. It is also quite pleasant to know that the Nobel prizes are not the only ones in existence; they are merely the highest awards for outstanding achievement. There are other and smaller awards for lesser accomplishments.

But even the laudatory custom of awarding cash for accomplishment can miscarry, as was proven, for example, in the Wolfskehl Prize. The prize itself brings us to the core of this story. The reason for establishing the prize, however, lies a few centuries back and has to do with the habits of the well-known French mathematician, Fermat.

Pierre Fermat lived from 1601 to 1665 and was the King's councilor in the local Parliament of Toulouse. Mathematics was his hobby, not his profession. But he is now considered the founder of the theory of numbers. He came very close to being the inventor of differential calculus and had a hand in establishing methods for calculating probabilities. As for his official duties, he seems to have discharged them well.

After having finished with being the King's councilor for the day – rarely strenuous work, one would guess – he would sit in his garden and read mathematical works. When new thoughts came to him, while reading, he would scribble notes on the margins. These notes were later published and quite naturally it is impossible to date them properly.

In 1621 Fermat purchased a new French edition of the *Arithmetica* of Diophantus of Alexandria, originally written during the Third Century. Now it was known in Diophantus' time that a right-angled triangle with the sides 3, 4, and 5 (also called Egyptian triangle) fulfilled the equation, $3^2 + 4^2 = 5^2$. Diophantus apparently wondered whether this applied to these three integers only and quickly found out that there is a very large (actually infinite) number of similar triplets. Generally then, in such triangles, it held true that $x^2 + y^2 = z^2$. Reading this, Fermat wrote on the margin: ". . . it is impossible to separate a cube into two cubes, a fourth power into two fourth powers, or, generally, any power above the second power into two powers of the same degree. I have discovered a truly marvelous demonstration which this margin is too narrow to contain." The date of this note is not known with certainty, although it must have been written after he bought his copy of the book.

If Fermat wrote down this proof elsewhere it has never been found. After his death, and after his many marginal notes were published, the problem was there. *The equation $x^n + y^n = z^n$ has no solution if n is larger than 2.* Every so often a mathematician would tackle this problem. The great Euler who lived from 1707 to 1783 proved that no solution (in whole integers) existed for $x^3 + y^3 = z^3$ and for $x^4 + y^4 = z^4$. Peter Gustav Dirichlet (1805–1859) then proved the impossibility for $x^5 + y^5 = z^5$.

These proofs were very useful, but they were not general proofs. Taking Fermat's statement at face value it should be possible to prove generally that the equation would not work for *any* number higher than 2. Euler and Dirichlet might have tackled the problem in much too complicated a manner. What a pity that Fermat did not carry a notebook out into his garden along with the books he took to read. He had irked mathematicians in precisely the same manner in a number of other instances, but they had always succeeded in finding the proofs that Fermat had failed to write down. This case became an exception.

Still, it remained a family matter among mathematicians until the year 1908. In that year a German mathematician, Professor Paul Wolfskehl, who had also worked on that proof without any success for a number of years, left the sum of 100,000 marks (roughly $23,500) for a general proof of what had become known as Fermat's last theorem. The news spread quickly, far and wide. The local mailman in Göttingen asked to be motorized* and the institute administering the Wolfskehl Prize quickly began to doubt the wisdom of the measure. Needless to say, the lure of 100,000 marks in gold was at least one major reason why a number of competent mathematicians suddenly took interest in the Fermat theorem. But the prize also caused innumerable laymen to devote their spare time to the problem. One of the solutions, I have been told, consisted of giving one numerical example for each power from 2 to 200; others were even more simple than this.

After awhile, when the 100,000 marks had begun to produce some interest (the financial kind at so much per cent per annum) the Institute began to hand out consolation prizes for partial proofs. Partly because of the Wolfskehl Prize, the matter has now progressed to the point where there are proofs of Fermat's theorem for any value of n up to 269, but a general proof is still lacking. It is easy to understand why a number of mathematicians feel that Fermat made a mistake, and that there is no general proof. As for the Wolfskehl Prize, it died during the German inflation. Even if Fermat did not make a mistake, and even if somebody should find the general proof now, the honor (and

* This was not done. The horse-drawn parcel post wagon made a daily delivery instead.

probably a professorship) will have to be reward enough for the discoverer.

In the course of the investigations which had been initiated and stimulated by Fermat's marginal note, disposal was quietly made of a famous problem of antiquity. It was the problem of doubling the cube. The story goes that an epidemic disease raged in Greece in about 400 B.C. and that Apollo's oracle promised the end of the disease if the altar in the temple were doubled in size. That order seemed simple of fulfillment but even after the new altar had been built the epidemic did not stop. Then the oracle announced that the order had been misunderstood. The original altar had been a cube; the new altar was to be a cube, too, except double the size of the original. This order could not be obeyed exactly and although the epidemic evidently waned, after awhile, the problem remained to be solved.

If we designate the side of the cube by a, the volume of the cube will be $v = a^3$. A second cube whose volume, V, is double that of the first would have a volume of $V = 2v = 2a^3$ and the length of its side would consequently be $a^3\sqrt{2}$. Since $\sqrt{2}$ is an incommensurate number, the sides of the new cube cannot be measured exactly and consequently a second cube, whose volume is double that of the first cannot be constructed. Since this problem was recognized (and disproved) before Nobel and Wolfskehl began to excite the imagination with heaps of gold pieces, no financial interest was ever involved in that problem.

Prime Interest

There was once another prize, even if only a small one of 1,000 German marks, that had to do with the construction of prime numbers. It, too, probably vanished during the inflation but it stirred up considerable interest in another phase of mathematics.

A prime, as everybody knows, is a number which has no divisors except itself and 1. Prime numbers, needless to say, caught the fancy of even the earliest mathematicians and Eratosthenes of Cyrene (who was the first to attempt to measure the size of the earth and found a figure remarkably close to the truth) devised what is still called the sieve of Eratosthenes. It consists simply in writing down the integers 1, 2, 3, 4, 5, . . ., and then striking out all multiples of 2, then all multiples of 3, and so on, until only the primes are left. In the first hundred they are: 1, 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, and 97.

The sequence looks quite irregular, but it seemed as if there ought to be some hidden order in the appearance of primes; it merely remained to find it. Obviously, primes became rarer the higher one went along the line of the positive integers. The same applied to the so-called "pairs" which are two primes separated only by one even number, like 11 and 13, 41 and 43, or 71 and 73. The first question was: "Will the primes stop somewhere, in the region of very large numbers?" That question had been disposed of early by Euclid.

"Let's imagine," he said, "that there is a largest prime which we'll call P. Now we multiply all known primes $1 \times 2 \times 3 \times 5 \times 7 \times 11 \times 13 \times 17 \times 19 \ldots$ and so on, until we come to P. The product of all these integers, a number very much larger than P, we shall call Z. Now $Z + 1$ either is a prime or it is not: If it is, we have a prime larger than P; if $Z + 1$ is not a prime, the divisor cannot lie between 1 and P, since there would then be a remainder, 1. Therefore, the divisor would have to be an integer between P and $Z + 1$. Since that divisor would have to be a prime itself it would also be a prime larger than P."

Since Euclid had proved that there was no highest prime, it was natural to look for a similar proof that there was no highest pair of primes. Apparently, such a proof has still to be found, but it was felt that this proof might be derived as a kind of by-product from a formula which permitted the construction of very large prime numbers.

Fermat believed that he had found such a formula. He was in error, however, which is the main reason for the skepticism with regard to the proof for his last theorem. Fermat had thought that the equation, $2^x + 1 = P$, where P is a prime number, would produce primes, provided that the x was of the form 2^n with n a positive whole integer. The first few steps yield the following primes:

$$\begin{aligned} 2^2 + 1 &= 5 \\ 2^{2^2} + 1 &= 17 \\ 2^{2^3} + 1 &= 257 \\ 2^{2^4} + 1 &= 65{,}537 \end{aligned}$$

Unfortunately, the next step miscarried. $2^{2^5} + 1$ (or $2^{32} + 1$) is 4,294,967,297 and Euler proved that this is divisible by 641. The next number in the sequence is 18,446,744,073,709,551,617 which is not a prime since it is divisible by 274,177. Two formulas, developed after Fermat, also produce primes for awhile. For example, $n^2 - n + 41$ produces primes for any value of n up to 40. The 41st step turns out to yield a square, not a prime. Similarly, the formula $n^2 - 79n + 1601$ produces primes for n up to 79 and breaks down at the 80th step.

No Prize

The problem of a formula for a construction of large primes is still unsolved. Possibly the proof should go the other way round and show that such a formula is impossible. At any event there is no longer a prize for finding prime numbers.

The attempt to find a formula for the construction of large primes was not the only contribution which Fermat made to this problem. He stated, for example, that a number of the form $n^p - n$ is divisible by p if n is any whole number and p any prime. If, for example, $n = 15$ and $p = 3$, we get $(15^3 - 15) = (3375 - 15) = 3360$ which is divisible by 3. Fermat left no proof, but that was supplied by Leibnitz.

Another one of Fermat's proofless assertions (but he wrote that he had a proof) was the statement that any prime of the form $4n + 1$ is the sum of two squares and only one set of two squares. Let us consider any multiple of 4, such as 40, for example, and add one. If the result (41) is a prime (which is the case) it must be the sum of two squares in just one way. It is,

(*Continued on page 248*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

For Merit

THE highest honor that can be bestowed on a civilian in recognition of outstanding service to the nation – the Medal for Merit – has been awarded to George R. Harrison, Dean of the School of Science at M.I.T. The medal was presented to Dr. Harrison on December 31, 1948, by Karl T. Compton, chairman of the Institute's Corporation and chairman of the Research and Development Board of the National Military Establishment in Washington.

The award was made in recognition of Dean Harrison's services as a scientist during World War II. He earlier received the Medal of Freedom for his war services. The citation accompanying the medal, which was signed by President Truman, follows:

"For exceptionally meritorious conduct in the performance of outstanding services to the United States from July, 1940, to June, 1946. Dr. Harrison, as Chief of the Division of Optics and Chief of the Division of Physics of the National Defense Research Committee, and as Assistant Chief of Field Service of the Office of Scientific Research and Development, was among the first of the Nation's senior scientists to recognize the need for vigorous concentration on the development of new weapons and improved methods of warfare. Early foreseeing the importance of guided missiles, he initiated the project which resulted in the azon and razon dirigible bombs. His recognition of the potentialities of infra red rays resulted in prompt development of the metascopes and of equipment for signalling in secrecy; and of the long wave equipment for the detection of enemy personnel, vehicles and ships. He guided the development of optical equipment, notably reflex gun sights and high altitude high resolution aerial cameras with great effectiveness which resulted in providing much improved equipment to the armed services. Through Dr. Harrison's unceasing and selfless efforts, he was responsible for organizing, initiating, stimulating and personally guiding research and development investigations culminating in equipment and methods which saved the United States many lives, and increased our effectiveness in the war."

Dr. Harrison joined the staff of M.I.T. as professor of physics in 1930, and has been dean of the School of Science since 1942. He traveled widely in New Guinea and Australia on scientific missions during World War II.

Modern Alchemist

MEDIEVAL alchemists were primarily occupied with the problem of converting base substances into noble metals (principally gold) of high intrinsic value. Of course they were doomed to failure, and it is only during the Twentieth Century, when artificial transmutation became possible, that anything like the alchemists' dreams could be said to have come true.

But one great lesson which research teaches is that valuable by-products, which at first seem to have no apparent connection with the problem at hand, often come from the pursuit of worth-while causes. It is pleasant to record, therefore, that one of the Institute's modern alchemists has created gold out of something much less tangible than the brewing concoctions which, centuries ago, were thought to yield the yellow metal. What is more, two varieties of gold have been produced. One of these – and the more valuable of the two – is a rather intangible, colorless substance of such subtle properties that it is not listed in the periodic table; it is the direct outgrowth of a life of teaching, research, and professional activity. The second variety – the customary yellow metal of atomic weight 197 and entered as element 79 in the periodic table – has been produced in small quantity as a by-product of the first.

The by-product was announced by Lawrence H. Flett, '18, President of the American Institute of Chemists, in a statement that Warren K. Lewis, '05,

M.I.T. Photo

As chairman of the Research and Development Board of the National Military Establishment in Washington, Karl T. Compton awards the Medal for Merit to George R. Harrison, Dean of Science.

Emeritus Professor of Chemical Engineering at M.I.T., has been unanimously selected to receive the 1949 gold medal of the American Institute of Chemists. The award is made annually for "noteworthy and outstanding service to the science of chemistry or the profession of chemist" and has been made this year in recognition of Dr. Lewis' administrative ability, leadership, and outstanding success as a teacher. Presentation of the medal to Dr. Lewis will be made at the annual meeting of the American Institute of Chemists to be held in Chicago on May 6 and 7.

The pioneering work in chemical engineering which Professor Lewis has done since his graduation from the Institute in 1905 has brought him other honors as well. In 1937 he was awarded the honorary degree of doctor of science from the University of Delaware, and Princeton University awarded him the degree of doctor of engineering in 1947. In 1936 Professor Lewis was awarded the Perkin Medal of the Society of Chemical Industry for valuable work in applied chemistry, and in 1947 the American Chemical Society awarded him the Priestley Medal. Professor Lewis was voted one of the "ablest chemists and chemical engineers working in the United States" by the Chicago Section of the American Chemical Society, and in February, 1948, he was awarded the President's Medal for Merit with the following citation:

"For exceptionally meritorious conduct in the performance of outstanding services to the United States during the recent war period. Dr. Lewis, as a member of Division II of the National Defense Research Committee, contributed a singularly great service to the war effort in organizing and inspiring the chemical engineering activities of the Committee on the problems of the Chemical Corps, especially those connected with gas masks, canister design, and the theory of aerosol generators and filtration. Dr. Lewis' services in this field and in connection with chemical engineering problems in the development of the atomic bomb were of inestimable value to the ultimate victory."

Technology Alumni who were previous recipients of the medal of the American Institute of Chemists are: Robert P. Russell, '22, of the Standard Oil Development Company; and Charles A. Thomas, '24, of Monsanto Chemical Company.

Inauguration and Mid-Century Convocation

CAMBRIDGE will be the scene of events of international importance, and a new chapter in M.I.T. history will begin this spring, when James R. Killian, Jr., '26, will be inducted as the Institute's tenth president. Prior to the inauguration, on March 31 and April 1, the Institute will conduct a Mid-Century Convocation on the Social Implications of Scientific Progress in celebration of this administrative change.

With the United States emerging as the leader in science and technology after World War II, and with M.I.T. playing an outstanding part in the nation's scientific and engineering progress, it is appropriate that President Killian's inauguration provide opportunity to survey the progress which has been made in science and technology during the Twentieth Century. And, since our social and political institutions have been literally revolutionized as a result of applied science during the last five decades, it is especially appropriate that the social implications of science come into focus. With this thought in mind, the convocation has been planned to provide opportunity for scholars in various branches of learning, and from all parts of the world, to examine and assess the progress of science since the electron was discovered, to deal with the tremendous changes which scientific progress has wrought in our social, economic, and political institutions in the same period, and to deal with the role of the individual in a society of ever increasing complexity. Scholars from various parts of the world have been invited to take part in this program which holds promise of significance in forecasting the trend of events for the second half of the Twentieth Century.

Climax of the three-day celebration will be the colorful pageant in which Karl T. Compton, chairman of the M.I.T. Corporation, will induct Dr. Killian as the Institute's new president. Leaders in science, engineering, and higher education, as well as many Technology Alumni, will attend the inauguration ceremonies, the last one of which was held in 1930 when Dr. Compton became president. As the program is further developed in the weeks to follow, additional details will appear in The Review which will also publish a full account of the events of March 31, April 1, and 2 in the May issue.

Graduate Study for Executives

TEN young executives from various fields of business will be chosen in a national competition for a year of graduate study in the Sloan Fellowship Program for Executive Development at M.I.T., James R. Killian, Jr., '26, President of the Institute, announced in January.

The opening of the competition marks the resumption, after a recess during World War II, of a program which started in 1931, and has been supported for several years by grants from the Alfred P. Sloan Foundation, Inc. This program is a joint project of the Institute's Departments of Business and Engineering Administration, and Economics and Social Science. The award of 10 fellowships this year is made possible by a new grant of $225,000 from the Foundation to cover a program of research in the field of executive development and education for a group of outstanding young business executives.

Gerald B. Tallman, Associate Professor of Marketing, of the Department of Business and Engineering Administration, is director of the Sloan Program and will supervise the selection of the fellows and their work during their year in residence at M.I.T. In discussing the objectives of the program, Dr. Killian made the following statement:

Informed and thoughtful business leadership is of great importance in our industrial society. Increasingly, top executives must balance policies and programs to serve equitably all of the participants in the enterprise, thereby enhancing the survival values of our democratic industrial system. The Sloan Fellowship Program for Executive Development was originally founded in recognition of the increasing need for business leaders with a fundamental un-

President James R. Killian, Jr., '26, was the recipient of honors in the City of Brotherly Love on December 14 when Drexel Institute of Technology conferred upon him the honorary degree of doctor of engineering, in ceremonies recognizing the leadership of three outstanding educators. Shown here, left to right, are Harold E. Stassen, President of the University of Pennsylvania, James R. Killian, Jr., M.I.T. Head, and Louis P. Hoyer, superintendent of Philadelphia public schools – all of whom received honorary degrees from James Creese (extreme right), *President of Drexel Institute of Technology.*

The Photo-Illustrators

derstanding of the broader and longer-term phases of management and of the economic and social background within which business operates.

The program continues to maintain, as its primary objective, the rapid and more adequate preparation of capable young executives for positions of higher responsibility in industry. The objectives of this program are accomplished through the close association of a small group of exceptionally able men, studying and evaluating business problems and underlying socio-economic forces, in an environment rich in both stimulation and resources.

The fellowships, awarded on the basis of merit in a nation-wide competition, will carry stipends up to $4,000 for married men and $3,000 for single men. Recipients, on leave of absence from their employers, will be in residence at the Institute from June 10, 1949, to June 15, 1950, and will engage as a group in a special program. In selecting the total group of approximately 10 fellows, an attempt will be made to have represented a diversity of industries, size of companies, geographic areas, and types of experience. In describing the Sloan Fellowship Program, Professor Tallman said:

The courses to be undertaken by the fellows are designed to capitalize upon their maturity and background and to offer an experience not otherwise readily obtainable by the young executive in industry. The practical problem approach is supplemented by study of underlying principles in the consideration of such problems as industrial relations, financial management, marketing methods and research, production, and accounting.

The work of the fellows also emphasizes in a practical way the responsibilities borne by industry in our economic and social activities and the effects of industrial operation upon other parts of the social structure. The better appreciation of the varying objectives and points of view of different elements in our society provides a foundation of understanding for intelligent administration of the individual business enterprise and for adjustment to new circumstances and attitudes as they arise.

The program does not attempt to develop experts in specific functional phases of business activity or in specific industries; rather, the thinking of the fellows is carried beyond the bounds of their own specialized activities and experiences. When attention is directed to problems and methods within the various functional divisions of an enterprise, their relation to other functions and to the overall operation is emphasized. When economic, social, or governmental problems are studied, their effect upon the administrative planning for the business enterprise is given major consideration.

The educational responsibility for this program rests with the Department of Business and Engineering Administration and the Department of Economics and Social Science. To supplement the educational resource of these departments, an important contribution is made by a distinguished group of industrial, government, and labor leaders meeting with the fellowship men in seminars at the Institute and in field trips away from the Institute.

Report on Student Activity

LAST year the Corporation passed a resolution proposed by the Visiting Committee on Student Activity* which read as follows:

Resolved, That it is in the interests of a sound educational program at M.I.T. to provide: (*a*) Dormitories adequate to accommodate the maximum number of students consistent with the housing needs of the student body and a stabilized enrollment at the Institute. (*b*) Athletic and recreational facilities adequate to accommodate all reasonable needs of student and faculty members who may wish to use them and to permit intercollegiate competition. (*c*) Facilities adequate for the conduct of extracurricular activities. (*d*) Administrative personnel adequate for the guidance and encouragement of student activities and athletics and of a balanced extracurricular program for the student body. (*e*) Freshman participation in athletics as a part of the educational program.

Resolved Further, That maximum benefit from activities, including athletics, will be attained only when the students assume full responsibility for the operation of these

*Members of this Committee for 1947–1948 were: Donald F. Carpenter, '22, chairman, Marshall B. Dalton, '15, H. W. McCurdy, '22, and J. Willard Hayden.

activities, the Administration and the Alumni Association assisting in an advisory capacity only, except in such cases where more direct action may be required to protect the reputation or properties of M.I.T. or to avoid any possible detrimental effect on the educational program.

Resolved Further, That the Administration and Executive Committee of the Corporation give these objectives serious consideration in the allocation of operating and capital funds.

The report of this Committee is largely one of comment upon progress which has been made in carrying out these recommendations.

Construction on a new dormitory, which is to be a Senior House, is now well along. This addition to our housing facilities will be available by the opening of the fall term in 1949. This dormitory will add accommodations for 362 students. This is a major step ahead in housing students at the Institute, but the Committee looks forward to the provision of additional dormitory units so that the Institute may ultimately meet all the demands on the part of the student body for dormitory accommodations.

The new Rockwell Athletic Cage was dedicated last June and makes a major addition to our athletic facilities. This structure, described in the November, 1948, Review, will enable the Institute, for the first time, to have an adequate indoor athletic program.

During 1947–1948, new tennis courts were completed in the area west of Massachusetts Avenue, and some progress was made in the further development of the playing fields in this area. Much remains to be done, however, to utilize fully the remaining land for playing purposes. This will require funds totaling ultimately about $70,000 which are not now available.

Progress has likewise been made in providing improved facilities for nonathletic activities at the Institute. Student lounges on the east side of Walker Memorial, including the balcony, have been refurnished and redecorated, with the result that they provide a much better environment for student use. The Litchfield Lounge on the first floor of Walker has been so arranged that it serves as a dignified setting for meetings of the Institute Committee, and the entrance to this room has been fitted out so that it serves as an office for the Institute Committee. A full-time secretary has been engaged to do the secretarial work of the Committee, and this office provides an adequate place for her work. The year also witnessed the completion and intensive use of the new Pritchett Lounge in Walker Memorial, a room designed and decorated to provide a place where students can enjoy bringing their friends and which they can use for other social purposes. The extent to which the students have made use of this lounge has justified the recommendation of this Committee several years ago that such a place be made available to our students.

Not quite half of the student body participated in athletics and other undergraduate activities in 1947–1948, so much remains to be done to extend recreational and athletic facilities at M.I.T., and plans have been developed for the ultimate facilities which will be needed. These include a gymnasium, an auditorium, and a faculty club, all of which would contribute importantly to providing proper environmental conditions at the Institute.

Important additions have been made to the administrative personnel, available for the guidance and encouragement of student activities, and of a balanced extracurricular program. Along with the appointment of Everett M. Baker, Dean of Students, an additional man has been added to the staff of the Office of the Dean of Students. At the opening of school in the fall of 1947, the Institute had, for the first time, a full-time director of athletics, and during the year the new Athletic Board, appointed by the president, has been created as a part of the administrative organization of the Institute. This Athletic Board, made up of representatives of the Faculty, the Alumni, the Administration, and the student body has replaced the Alumni Advisory Council on Athletics. The new athletic director has made great progress in developing a sound program of intercollegiate competition and an extensive intramural program. Additional funds provided by the Institute will enable him this next year to increase the coaching staff.

Another important addition to personnel has been the appointment of a director of musical activities, who co-ordinates work in the classroom and all the extracurricular musical activities. Under his stimulating guidance, there has been greatly increased participation by students, and we now have a flourishing symphony orchestra and glee club. The program has developed so that still additional personnel must be engaged to assist the director.

In addition to an increase in the funds available from the Institute for undergraduate activities, the Executive Committee approved an increase in the student fee for next year, so that the amount appropriated out of each tuition payment will now be $9.00 instead of $7.00 a year.

Early in the past academic year, the Faculty approved a program of compulsory athletics for freshmen, as recommended by this Committee.

Perhaps of more importance than these various developments has been the fine attitude which has been built up among the student body and the staff. Reports indicate that this year student government at the Institute, now completely recovered from World War II, operated with great effectiveness and that the principle of self-government was extended in several ways. The fraternities, through the Inter-fraternity Conference, have made steady progress in dealing with the co-ordination of fraternity activities at the Institute. The Institute Committee has increased its prestige, and experiments have been undertaken by the students themselves in working out an honor system for quizzes and examinations. During the year most members of the Faculty took responsibility for acting as friendly counselors for half a dozen freshmen each. In addition, the service and influence of the registration officers were extended.

Military Review

An unusually pleasant dinner meeting in Boston on December 1, 1947, provided a background for a discussion of the problem of integrating the Reserve Officers' Training Corps program into the curriculums of the highest ranking engineering and scientific in-

(*Continued on page 232*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

This is the story of a briefcase with a new combination lock. In fact, it is the story of a growing line of leather goods bearing the lock. The people who carry that luggage probably are conscious of nothing except that it looks very well indeed, and that the combination lock is new in design, easy to operate, and entirely reliable. What more should they ask?

But there is an inside story that they would never dream of. They would never think that there is any connection between a compact carried by the ladies, and a lock on a briefcase carried by the men. But there actually is. You see, the leather goods company wanted that lock to be as near perfect as possible. Like anybody with a new idea, it was fussy about reaching for perfection. So it went to a manufacturing jeweler to have the lock made. The idea was that such a company certainly could make the lock with the necessary beauty, precision and economy. It was an excellent idea, though somewhat unorthodox from the viewpoint of those who think only in terms of what is called "normal channels of trade." It is a pleasure to report that the association has proved to be extremely successful.

Revere entered this picture because the jewelry maker is an old customer for some of Revere's finest metals. Specifications for the lock included the use of solid brass for both exposed and operating parts for which beauty, reliability and corrosion-resistance are required. Die castings and also steel are used in their appropriate places, thus again demonstrating that there is no one metal suitable for every use, but that each metal has its proper field. Incidentally, solid brass is not only used in the lock, but also in the handle posts.

This case of the combination lock interests Revere not only because it uses Revere brass for quality, but because it represents a lot of imagination in selecting a fabricator. If a jewelry firm can make locks, perhaps a coppersmith could make earrings, and diversification would add to the security and profits of both. Imagination is a precious thing. Some people consider it the most important factor in business. Revere thinks it has some imagination, as have all good suppliers to business. Whatever it is you make, Revere suggests you ask your suppliers to do a little thinking with you and for you. After all, every bill you pay, as well as every one you send out, includes an inevitable charge for brains, know-how, imagination.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

☆ ☆ ☆

Executive Offices:

230 Park Avenue, New York 17, N. Y.

THE INSTITUTE GAZETTE

(*Continued from page 230*)

stitutions by members of the Visiting Committee on the Department of Military Science and Tactics.* This problem has always been a difficult one. To maintain its high scholastic standards, M.I.T. prescribes a course of study and recitations which takes up nearly all of the students' available time, and which the Institute does not consider feasible to reduce. Also requiring students' time is the Army or Air Force which is required by the National Defense Act to present a course of three hours' instruction per week in basic military science and five hours per week in the advanced course. This schedule is the minimum which the writers of the National Defense Act considered satisfactory to produce second lieutenants of the Reserve Officers' Training Corps. At most colleges and universities where Reserve Officers' Training Corps units have been established, this program in military science has been accepted without alteration. At a few, where it was felt that five hours per week for the advanced course was too much for the students to carry in addition to their other studies, certain academic subjects have been substituted for some of the Reserve Officers' Training Corps courses. This change in the students' program is permitted by the National Defense Act, if approved by the Secretary of the Army or Air Force but these compromise agreements have not been thoroughly satisfactory to either party.

It is certainly desirable that Reserve Officers' Training Corps students be given the complete course of instruction in military science, in order that they may be reasonably well qualified as reserve officers. It is equally desirable, however, that they be as thoroughly trained in engineering or scientific fields as practicable. Also, it is important that a fairly large number of men so qualified be procured as Reserve and Regular Army officers.

It is believed that an acceptable compromise agreement might be based on the following program which is proposed for consideration:

1. Acceptance, by the Army, of a program in advanced military science, to include three classroom hours per week of military science subjects.

2. Agreement, by the college or university, that students participating in such a program will be required to take instruction for two classroom hours per week in subjects to be agreed upon between the Army and the institution. Subjects in this category would fall in one of the two following classifications: (*a*) Subjects acceptable to all arms and services, such as Personnel Management, Psychology, Group Psychology, Man-

(*Continued on page 234*)

*Members of this Committee for 1947–1948 were: Thomas C. Desmond, '09, chairman, C. George Dandrow, '22, Brigadier General William F. Heavey, '22, Colonel Benjamin S. Kelsey, '28, General J. Lawton Collins, J. Willard Hayden, and Major General Frank A. Keating.

ESTABLISHED 1915

Sign of a Great Line of
Materials Handling Equipment
for 33 Years

Multiply your Manpower, Speed up Production, Cut Overhead, and Save Money with Lewis-Shepard Power Fork Trucks, "JackLift," "JackStacker," and "JackTractor," Power Model Trucks, Hydraulic and Mechanical Hand Lift Trucks, "JackLift" Trucks, Pallet Trucks, Pallet Stackers, Portable Elevators, Cranes, Floor Trucks, Skids, and Racks.

Write for New Catalog of this Great Line

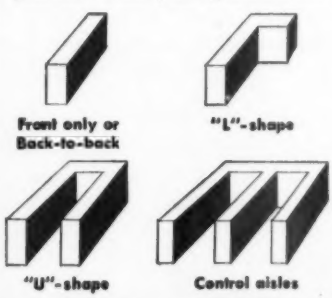
LEWIS-SHEPARD
PRODUCTS INC.
251 WALNUT STREET WATERTOWN 72, MASS.

REPRESENTATIVES IN PRINCIPAL CITIES CONSULT YOUR PHONE DIRECTORY

HOW ONE OPERATOR CAN BE IN *8 places at once*

INVESTIGATE!

Westinghouse Control Centers are ideally suited for nearly any kind of floor arrangement—with front only or back-to-back mounting. Below are some of the flexible arrangements possible to suit your special needs.



Putting skilled operating men in several places at once is a practical step toward producing *faster, better, cheaper.* That's why more and more plants are installing modern Westinghouse Control Centers.

In one place, a single operator can handle all units of a synchronized operation and at a glance can determine whether the operation is functioning properly. In case of trouble, the operator can spot its source immediately. Costly "run-around" time is eliminated...which means fewer production delays, lower maintenance costs.

In a typical installation, a Westinghouse Control Center regulates the starting sequence of eight pumps, to supply a constant pressure level for a locomotive boiler servicing system. Cost of the centralized control installation was actually *less* than it would have been for individual controls located at each pump.

Ask one of our sales engineers to show you how the Westinghouse Control Center standardized units can be arranged to suit *your* special needs. Phone your nearest Westinghouse office, or write Westinghouse Electric Corporation, Dept. T, P. O. Box 868, Pittsburgh 30, Pa. J-85009

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

MORE PRODUCTIVE POWER FOR INDUSTRY

ARTISAN
METAL PRODUCTS INC
EQUIPMENT FABRICATORS
WALTHAM
MASS U S A

THE HALLMARK of SUPERIOR EQUIPMENT

Artisan engineers and workmen are skilled in the techniques of metal working. Their combined knowledge and experience in engineering and building special equipment and machinery have been of value to many leading mechanical and process industries.

Write for a copy of "Process Equipment". For a qualified engineer to call to discuss your equipment requirements, telephone WAltham 5-6800 or write to: — James Donovan, '28, General Manager.

AUTOCLAVES
CONDENSERS AND HEAT EXCHANGERS
DISTILLATION EQUIPMENT
EXPERIMENTAL EQUIPMENT
EVAPORATORS
MIXERS
JACKETED KETTLES
PIPE, PIPE COILS, AND BENDS
REACTORS
SPECIAL MACHINERY
TANKS

Artisan METAL PRODUCTS, INC.
73 POND STREET, WALTHAM, (Boston 54) Mass.

CO_2

GAS . . . LIQUID . . . SOLID (Dry Ice)

THE LIQUID CARBONIC CORPORATION
3100 South Kedzie Avenue, Chicago 23, Illinois

U. S. A.
28 Producing Plants
More than 50 Distributing Points

CANADA
Halifax to Vancouver

OVERSEAS
England, Cuba, Mexico, Venezuela, Colombia, Trinidad, Brazil

Liquid RED DIAMOND Gas and Dry Ice

THE INSTITUTE GAZETTE

(*Continued from page 232*)

agement of People, Technique of Executive Control, Industrial Relations, Labor Relations, International Relations, and Economic Principles; and (*b*) Technical subjects acceptable to a particular arm or service. Under such operation, the Corps of Engineers, for example, might accept such subjects as Engineering, Geology, Fluid Mechanics, Engineering Construction, Strength of Materials, and so on.

It is believed that such a program will insure that each graduate of the Reserve Officers' Training Corps will have received instruction for at least five hours per week in subjects of definite value to the Army or Air Force, including three hours' training in the prescribed Reserve Officers' Training Corps program. Officers who are trained under such a program should be well qualified.

The Army and Air Force Reserve Officers' Training Corps units at M.I.T. appear to be operating on a friendly and well co-ordinated basis; and, in the interest of economy of personnel and equipment, as well as in the interest of maintaining close and harmonious relations between the Army and the Air Force, it is believed advisable that the Army and Air Force units should continue to operate in an integrated organization as at present.

The question of increasing the length of the Reserve Officers' Training Corps summer camp from its present six weeks to eight weeks was discussed by the Committee. It is evident that any increase in the camp training period would curtail the earning power of the students during the summer. It would also probably meet with opposition from companies which now allow students in co-operative courses to attend the camp when they should be at the companies' plants, and might prevent some students from attending a second session of summer school as given by some institutions. The Committee recommends that the summer camp be maintained at its present length of six weeks.

The Committee noted that the problem of providing storage space for heavy equipment and artillery weapons has not yet been solved. It is believed that a reasonable amount of covered and heated space should be provided by the Institute for storage of, and instruction in, such equipment.

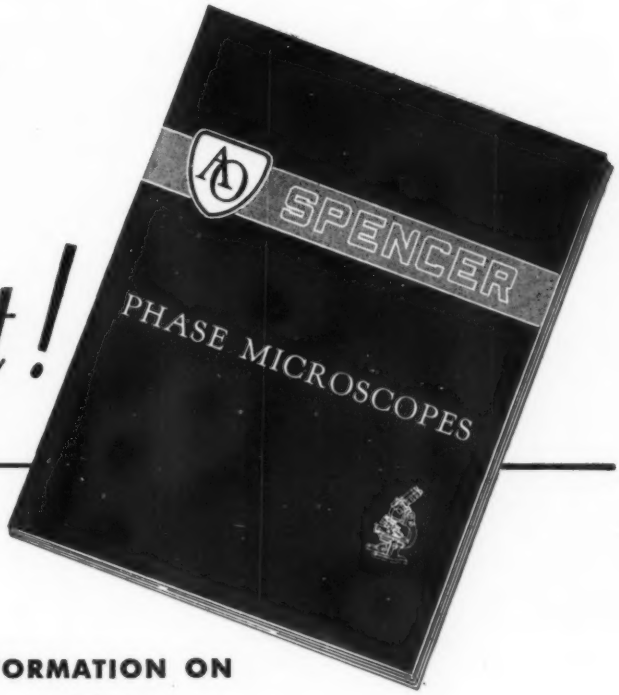
The Committee is of the opinion that the present indoor rifle range facilities are inadequate, and that a range with a minimum of 10 firing points should be provided at M.I.T.

Faculty Resolution

UPON the retirement of Karl T. Compton as president of M.I.T. and his assumption to his new post as chairman of the Institute's Corporation, the M.I.T. Faculty adopted a resolution setting forth their appreciation of the splendid accomplishments which have been achieved under President Compton's administration. Prepared and signed by Professors Wil-

(*Concluded on page 236*)

Now in Print!



COMPLETE INFORMATION ON

Phase Microscope

EQUIPMENT AND APPLICATIONS

This new booklet includes:

- ★ A brief history of phase microscopy.
- ★ Schematic diagram of light path.
- ★ Non-mathematical explanation of theory.
- ★ Chart showing 68 tested applications for phase microscopy — and suitable objectives for each application.
- ★ List of Spencer phase objectives in dark, bright and B-minus contrast.
- ★ The two Spencer phase condensers—turret and single unit.
- ★ Spencer phase microscopes and suggested optical outfits.
- ★ Complete bibliography on phase microscopy.
- ★ Numerous photomicrographs and other illustrations.

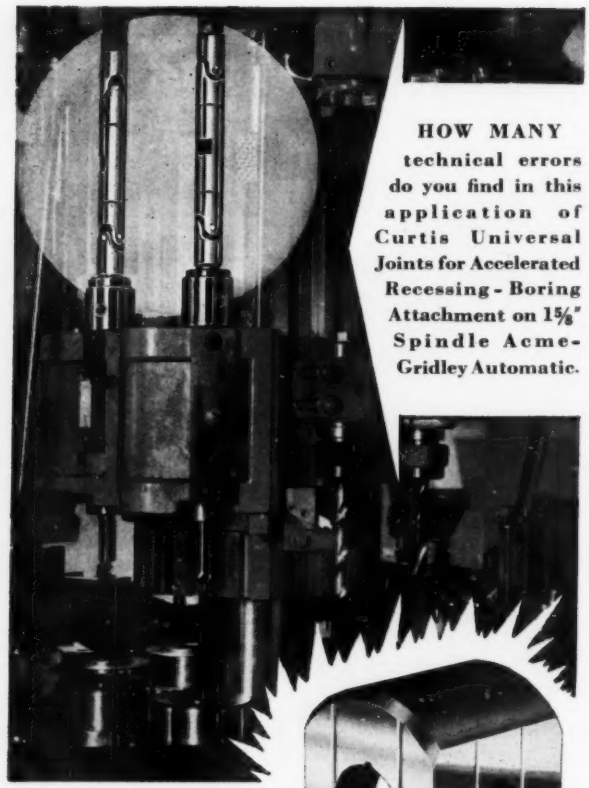
Phase Microscope No. 18 MLS

Much of this information has never been available before. For your free copy write Dept. O128.

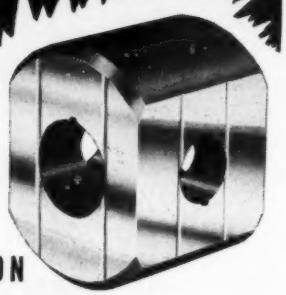
Phase Microscope No. 18 MAV

American Optical
COMPANY
Scientific Instrument Division
Buffalo 15, New York

Manufacturers of the **SPENCER** *Scientific Instruments*



HOW MANY technical errors do you find in this application of Curtis Universal Joints for Accelerated Recessing - Boring Attachment on 1⅝" Spindle Acme-Gridley Automatic.



"LO-FRICTION" CENTER BLOCK + PROPER-LUBRICATION = LONG-LIVED EFFICIENCY . . . . . .

Two features offered in Curtis Universal Joints in 1¼" or larger sizes, tend greatly to increase their efficiency and life as well as to eliminate costly shutdowns for replacements.

1 — The New Curtis "Lo-Friction Center Block" — with two grooves on each bearing surface — reduces the size of frictional areas — distributes wear more evenly and permits more efficient lubrication.

2 — Curtis pioneered proper joint lubrication many years ago with a patented oiler. This oiler directs oil through large pin into center of joint, where centrifugal force distributes it through scientifically designed passages, in and on the center block, to all essential points of wear.

Curtis does not use covers or boots packed with grease as a means of lubrication. Tests show grease or oil is thrown outward away from bearings by centrifugal force and onto the inner surface of such coverings.

When in need of industrial universal joints be sure of the best — Specify Curtis Universal Joints. Send for Engineering Data and useful drafting templates.

Write Dept. B-5

CURTIS UNIVERSAL JOINT CO. INC. SPRINGFIELD MASS.

THE INSTITUTE GAZETTE

(*Concluded from page 234*)

liam H. McAdams, '17, as chairman of the Faculty, and Joseph S. Newell, '19, as secretary, Herbert L. Beckwith, '26, William C. Greene, Jerome C. Hunsaker, '12, Warren K. Lewis, '05, and John C. Slater, the resolution sets forth a summary of accomplishments during the 18 years of President Compton's administration. The resolution reads, in part, as follows:

Resolved, That the Faculty do adopt and approve the following tribute to President Compton:

Since 1930, Doctor Compton has been our leader in the training of young men for professional careers in architecture, science and engineering, and in research to extend the applications of science.

He has also served as the administrator of a complex and expanding universe of facilities and people. With bold imagination, tempered with wisdom and humor, he has led us through a period of sound growth.

This growth took place under stormy but stimulating conditions. His inauguration took place at the beginning of the severe industrial depression of the 1930's which was soon to be complicated by social changes under new legislation. Then came war to take away most of the student body, many of the faculty, and to divert our laboratories to military ends. Finally, the Institute was to weather the post-war readjustment, with inflation of costs and a flood of returning veterans.

Doctor Compton guided the Institute safely through these difficult times, not only with its independence unimpaired, but materially strengthened and immensely elevated in prestige.

In eighteen years the faculty has grown with the facilities at their disposal from 240 in 1930 to 398. The educational plant has increased from a value of some $14,000,000 to nearly $20,000,000, total endowment funds from $33,000,000 to $48,000,000. The student body, in spite of ever higher standards of admission, has increased from 3200 to 5600. Emphasis on higher professional training is to be noted in the relative growth of the graduate school. In 1930 17% of the students were enrolled in the graduate school. In 1948, this proportion is 27%.

For Construction Industries

With an eye to the important future developments which may be expected to take place in building construction in the coming years, the Department of Building Engineering and Construction has issued a pamphlet setting forth the details of the course of study which the Institute offers in this important field of engineering.

Under the title "Training Engineers for the Construction Industry," the new 16-page brochure states the objectives of the undergraduate and graduate Courses in Building Engineering and Construction, outlines the program of study, and includes a description of the subjects currently offered.

Copies of the pamphlet have already been mailed to many actively engaged in work in the building and construction industres. Additional copies may be obtained on application to Professor Walter C. Voss, Head of the Department of Building Engineering and Construction at the Institute.

They have what it takes

TELEPHONE LINEMEN have the traditional Bell System spirit of service that aims to "get the message through." They also have what it takes *in the way of equipment and supplies.*

Their wires, cables, poles, tools and countless other things are provided by Western Electric—maker or supplier of practically everything used in your telephone service. We carry stocks of 31,000 different items to help all Bell telephone people, not only to do their daily job of maintaining and expanding telephone facilities but also to meet sudden emergencies.

• Western Electric has been a part of the Bell System for many, many years—ever since 1882. Our people share in the System's spirit of service. We, too, are always ready to answer the unexpected hurry call—to help "get the message through" for you.

MANUFACTURER of telephone apparatus for the Bell System.

PURCHASER of supplies for Bell Telephone companies.

DISTRIBUTOR of Bell telephone apparatus and supplies.

INSTALLER of Bell System central office equipment.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

THE PRICE OF HASTE

(Continued from page 219)

Americans safer air transportation. What should the air lines do?

First of all, they should emphasize safety rather than schedule. Air travel can save a busy man an enormous amount of time. It can save him much discomfort and inconvenience. It can enable him to accomplish things impossible in any other way. But it cannot yet assure him that he can fly from Boston to Washington at a specified time three weeks hence and do it in safety. To attempt fulfillment of false promises as to the maintenance of a schedule in all weathers with present equipment is to court disaster.

Then the air lines should equip their airplanes as rapidly as possible with ILS instruments and airborne radar of the type which warns a pilot of an obstacle, such as a mountain top, in his path. Pilots should be trained intensively in the use of these instruments. The weight of the ILS instruments and radar set may reduce the capacity of a plane by one or two passengers, but the equipment will materially improve the life expectancy of the passengers carried.

The air lines and their representatives should co-operate fully with governmental agencies seeking to improve the safety of air travel. It is disappointing to hear of the representative of the Air Transport Association of America on the President's Air Safety Board refusing to sign the report of the Board because it dealt broadly with the entire question of air safety and did not confine itself to the three much publicized crashes in May and June, 1947.

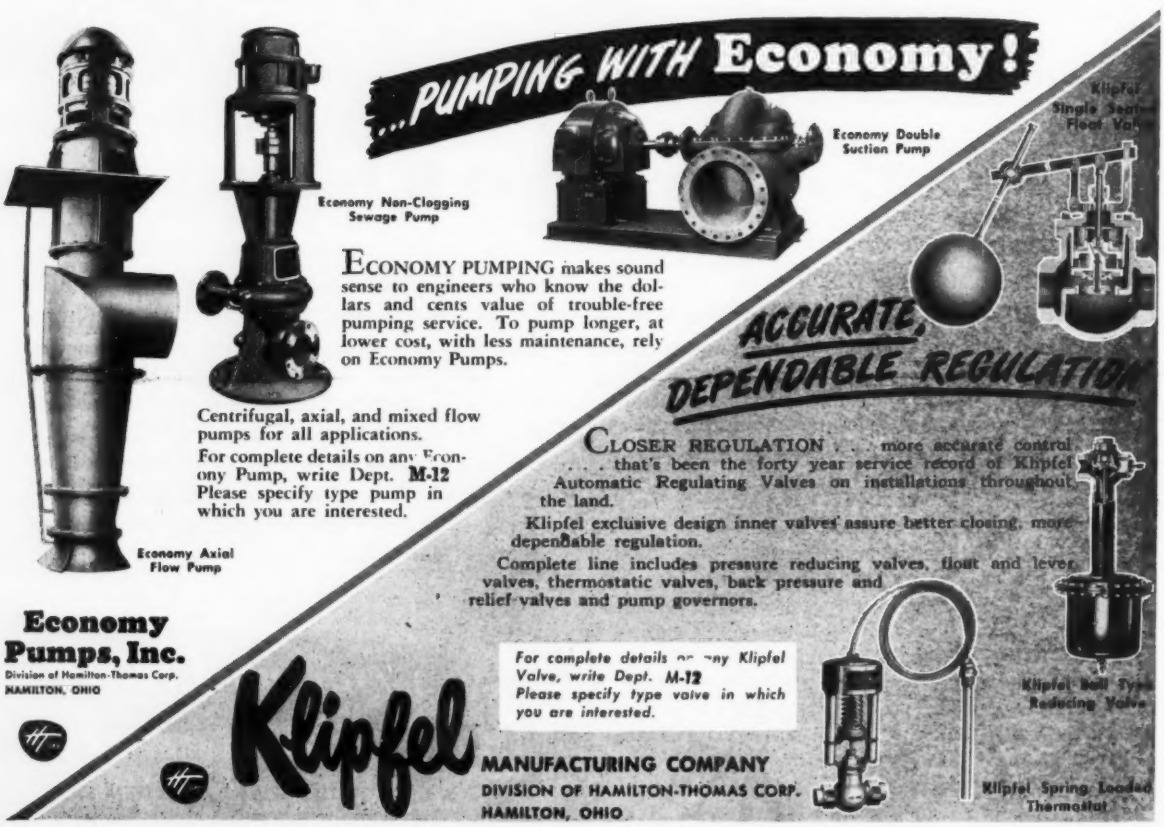
The air lines should hasten to use the best fields and terminal facilities available in the communities they serve; and they should not attempt to serve communities having inadequate fields. When new and improved fields become available at our big cities, the air lines should use them. A threat to continue the use of old and inadequate facilities, when new and adequate ones become available, is indicative of a readiness to sacrifice safety for profits. It is indicative of policies that will destroy the faith of the public in the integrity of air-line management.

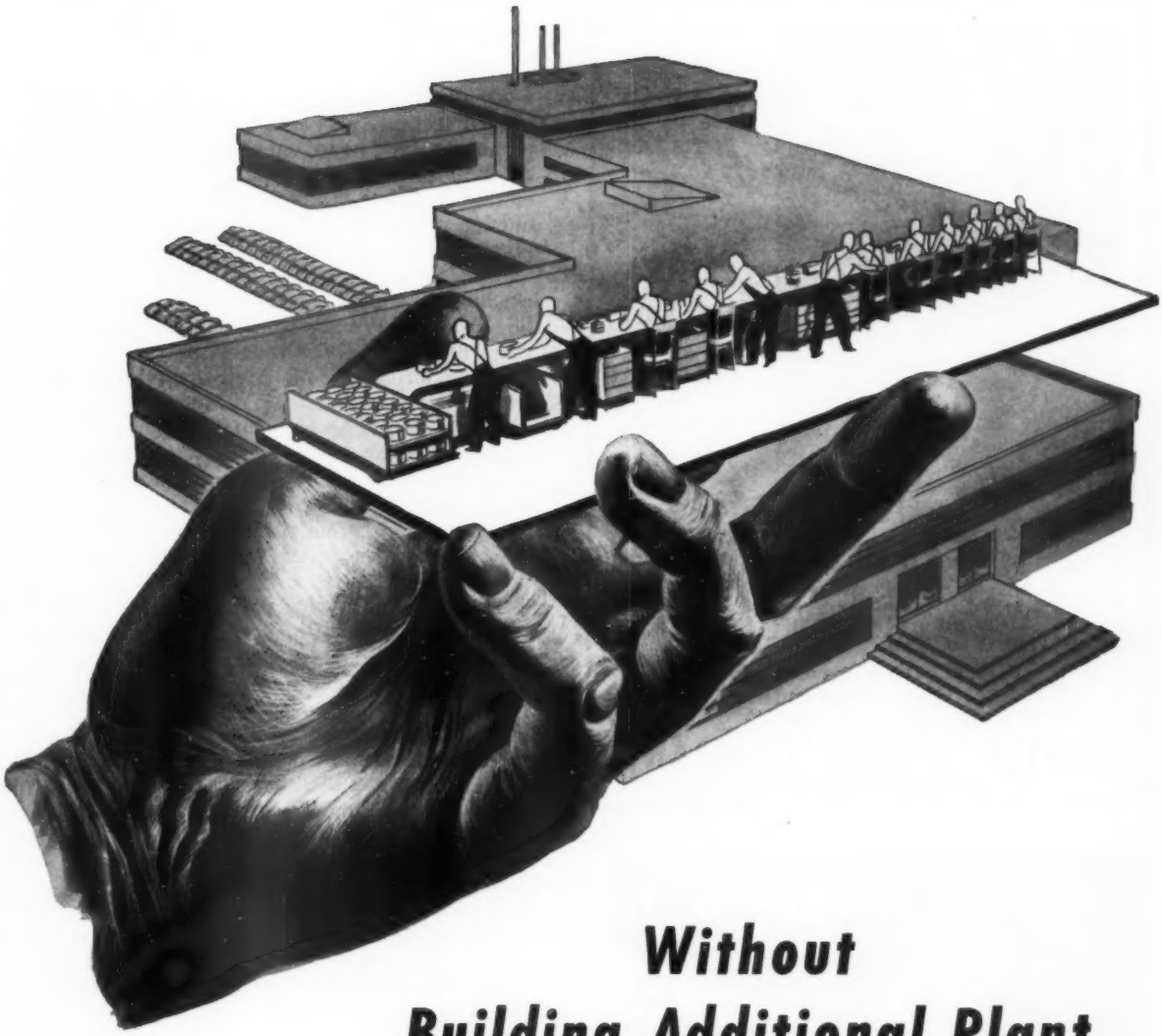
Finally, the air lines should publish and publicize their safety records. The air traveler has the right to authoritative information as to the safety as well as the speed of the transportation he purchases.

But what about the aircraft industry? What contribution to the increased safety of commercial air transportation may be expected of it?

We need, first of all, to reduce the fire hazard on airplanes. A great deal has been accomplished in this field. The fire detection devices and built-in CO_2 fire extinguishers carried by modern air liners are marvels of ingenuity. But these detection devices and extinguishers are palliatives which reduce a danger without striking at its roots. What is needed is the elimination of gasoline as a fuel on passenger-carrying transport planes. Research and experiment in fields leading to the development of practical oil-burning Diesel

(Concluded on page 240)


...PUMPING WITH Economy!
Economy Double Suction Pump
Economy Non-Clogging Sewage Pump
ECONOMY PUMPING makes sound sense to engineers who know the dollars and cents value of trouble-free pumping service. To pump longer, at lower cost, with less maintenance, rely on Economy Pumps.
Centrifugal, axial, and mixed flow pumps for all applications.
For complete details on any Economy Pump, write Dept. M-12 Please specify type pump in which you are interested.
Economy Axial Flow Pump
Economy Pumps, Inc.
Division of Hamilton-Thomas Corp.
HAMILTON, OHIO
ACCURATE, DEPENDABLE REGULATION
CLOSER REGULATION . . . more accurate control . . . that's been the forty year service record of Klipfel Automatic Regulating Valves on installations throughout the land.
Klipfel exclusive design inner valves assure better closing, more dependable regulation.
Complete line includes pressure reducing valves, float and lever valves, thermostatic valves, back pressure and relief valves and pump governors.
For complete details on any Klipfel Valve, write Dept. M-12 Please specify type valve in which you are interested.
Klipfel
MANUFACTURING COMPANY
DIVISION OF HAMILTON-THOMAS CORP.
HAMILTON, OHIO



Without Building Additional Plant

you can add another production line to your own

When your manufacturing departments are overloaded, try Taft-Peirce Contract Service *before incurring heavy fixed charges for new plant construction.*

Even though the volume may be large, the product complex, Taft-Peirce has the facilities, the experience, and the trained manpower to help you over that production hump. We can duplicate the effort of part, or all, of your production facilities. More than 1500 machine tools and 400,000 square feet of floor space can be placed at your disposal to produce your products in small quantities or continuous carload lots.

If you would like more information about how Taft-Peirce supplements production capacity in countless American industries, and how our facilities can become a *part-time part* of your plant, too, write for the illustrated booklet, "Take It To Taft-Peirce." Address the Taft-Peirce Manufacturing Company, Woonsocket, Rhode Island.

For Designing, Tooling, Contract Manufacturing

TAKE IT TO TAFT-PEIRCE

STOP GAS SPILLAGE, STAIN and THEFT

GET FIL-GARD T. M. REG.

Whistling GAS TANK FILL SIGNAL

BUY IT at your service station, car dealer or write to us
Specify car, year model

SCULLY SIGNAL COMPANY
70A FIRST ST., CAMBRIDGE 41, MASS.

CONTROL WITHIN ½° F.

REPORTED BY USERS

Most Accurate Water Mixer Made

Widely used for X-Ray and Color Film developers and other processes requiring exact control; also for shower baths.

Thermostatically mixes hot and cold water and delivers a mixture at any constant temperature required.

Outstanding for its quick acting response to any change in temperature setting or changes in supply line temperatures or pressures. (849)

½" Pipe Connections

Capacity 6 to 10 gals. per min.

•

Other Controls for Capacities up to 10,000 gals. per min.

THE POWERS REGULATOR CO.
2746 GREENVIEW AVENUE, CHICAGO 14, ILLINOIS
Offices in 50 Cities • See your phone book • Established 1891

Write for Bulletin 358-H

POWERS THERMOSTATIC WATER MIXER

THE PRICE OF HASTE

(*Concluded from page 238*)

aviation engines and oil-burning turbines should be pushed forward intensively. Such research and experiment should be looked upon not merely as a project promising improved fuel economy and lower operating costs, but as a project promising a marked reduction in one of the fundamental risks of air transportation.

Certainly we need airplanes driven by oil-burning machinery that will free us from the hazards of gasoline as a fuel. We also need improved wing sections that will make possible the development of high-speed transport airplanes capable of operation from relatively short runways. Again it must be admitted that much has already been accomplished. But there is still a lot to be done in the field of wing design if each marked increase in the size of transport planes is not to be accompanied by the necessity of longer runways and larger fields, or the risky business of operating the newer and larger airplanes from fields which are too small for them.

This brings us to what the air traveler should do to improve the safety of his favorite means of transportation. He should, first of all, use the air lines, but he should use them intelligently. The inevitability of occasional delays due to bad weather should be reckoned with in planning air travel, and such delays, if they occur, should be borne with patience.

The air traveler should watch the performance and safety records of the lines he uses. Patronize the lines that follow conservative policies in matters regarding safety. Patronize the lines that consider safety before schedule. And, last of all, don't be afraid to exercise your own judgment as to the wisdom of making a trip by air or other means. Don't be persuaded by air-minded friends into making flights that you consider risky. After all, it's your life that's at stake. Don't offer to put it up as part of the price of haste.

THE TREND OF AFFAIRS

(*Concluded from page 214*)

pounds can be read in total stresses of as much as 5,000,000 pounds.

A catwalk elevator encircles the machine, and permits the engineers to work at any desired level, setting up their test specimens with the help of an overhead crane. When the actual test begins, observers stand on the elevator behind a safety screen of steel plate and bullet-resisting glass.

The Navy's Bureau of Aeronautics did not build this Gargantuan testing machine solely for airplane design problems. It hopes that the huge device will be of service to various other bureaus in the Department, as well as to industry and to university research groups. It points out that one of the most valuable contributions the machine will make is an improved understanding of the mathematical relationships between full-scale test data and the data taken from tests on models.

Establish Your Trust With "Discretion"

The proper exercise of "discretion" under a will or trust requires the best judgment obtainable. Such judgment is developed from long and varied experience. Since 1871, The New England Trust Company has been charged with exercising discretion in serving as trustee under wills and living trusts.

Changing conditions make it not only advisable but necessary that your will or trust be written to give your trustee a practical amount of discretion. Only in this way can you be sure your widow, daughters, or sons will be protected against change in an unpredictable future. One of our trust officers will be happy to discuss your plans with you and your lawyer. You, of course, incur no obligation.

The

New England Trust Company

135 DEVONSHIRE STREET

At the Corner of Milk Street

BACK BAY BRANCH : : 99 NEWBURY STREET

BOSTON, MASS.

BANKING FOR NEW ENGLAND

Member Federal Reserve System

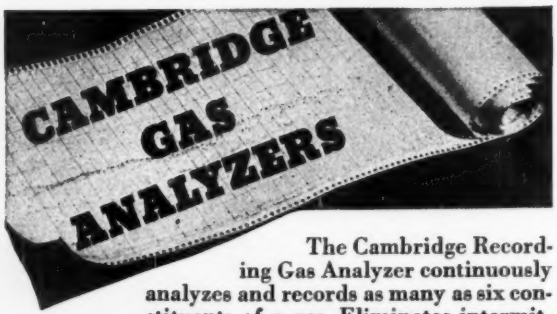
SIMPLEX-ANHYDREX CABLES

For power, control, and communication circuits buried directly in earth, installed in ducts, or exposed to open air.

Anhydrex insulation and a neoprene jacket provide sound electrical properties and protection against moisture, soil acids and alkalies, sunlight, heat and bad weather. Absence of lead sheaths eliminates electrolysis and corrosion and assures easy installation and maintenance.

For more complete information, plus dimensional data, send for booklet 985-A.

SIMPLEX WIRE & CABLE CO.
79 Sidney St., Cambridge 39, Mass.



The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

Makes possible substantial savings in the operation of kilns, production of inert gases, and in metallurgical, petroleum, and other chemical processes. Single- and Multi-point instruments are available for a wide variety of applications.

Send for literature mentioning application

CAMBRIDGE
INSTRUMENT COMPANY, INC.
3707 Grand Central Terminal, New York 17

Pioneer Manufacturers of

PRECISION INSTRUMENTS

MAIL RETURNS

(*Concluded from page 204*)

pioneer in the electromechanical transducers which characterized the Nineteenth Century uses of electricity in electric communication and electric power.
New York 14, N. Y.

Taking Exception

FROM BARNETT F. DODGE, '17:

I was much interested in the article in the December, 1948, Review on André-Marie Ampère. I must, however, take exception to two statements made by the authors. They imply that Lavoisier was the discoverer of oxygen. I believe that it is well agreed by most authorities that Priestley was the discoverer and not Lavoisier.

I should also like to point out that Mt. Blanc is not the highest in Europe by any means. There are several higher mountains in the Caucasus, and Mt. Elbruz is the highest in Europe, being nearly 3,000 feet higher than Mt. Blanc.
New Haven, Conn.

Influence on Economics

FROM WALTER R. INGALLS, '86:

As a B.S. of 1886 and one who listened to General Walker on economics, I was flabbergasted to read on page 52 of your issue for November, 1948, that the teaching of economics at M.I.T. has been greatly influenced by the writings of the late Lord Keynes, which would distress General Walker, if he were alive, as it does his living disciples.
Georgetown, Mass.

THE CASE AGAINST THE REBEL PAINTERS

(*Continued from page 220*)

By and large, however, incongruity, not social comment, is the stock in trade of the rebel painters. Said the cubist, Apollinaire:[8] "You may paint with whatever you please – with pipes, postage stamps, postcards or playing cards, candelabra, pieces of oilcloth, collars, printed newspapers." It may be supposed that where the theme is the juxtaposition of the unrelated, the technique or medium is, of course, an irrelevancy.

Since the heyday of the impressionists, the cult of the artist as ego has reigned supreme. The mind's eye of the painter takes the place of the object; or at least his insight may be said to rival his eyesight. The artist's own aesthetic experience need have no relationship to any perceived reality. For there is a superreality, the interior universe of the artist's own imaged experience. The dethronement of the objective world means the establishment of the illusions of nonobjective art, which, according to the German expressionist, Kandinsky,[9] "is destined to fling open the door into a world of mysteries vaster than those known to science or mechanics."

The scientist, the mechanic, the technologist are a villainous trinity for the rebel painters, who have been literally fascinated for two generations now by the

cultic search for the esoteric, mysterious, mystic. Probably nothing has given them more inspiration than the museum collections of primitive art. They are deeply indebted to the primitive for leading them to the arcana of a new-old art – magic. Said Kandinsky:[10] "Art is looking for help from the primitives." To which Chirico[11] adds: "Perhaps the most amazing sensation passed on to us by prehistoric man is that of presentment. We might consider it as an eternal proof of the irrationality of the world." An aesthetic protest against a technological civilization, this obsession with the irrational – Salvador Dali,[12] for instance, revels in it for scores of pages in his *Secret Life* – appears to spread throughout the range of modern painting.

Few modern painters have exemplified this mania for the irrational better than the Dadaists and the surrealists. Warned a surrealist manifesto[13] of many years ago (the rebel painters are fond of the word "manifesto"): "You have no idea how far our hatred of logic can take us." Since that time, observers of modern painting have seen that these words were not mere gesture. Visitors to the Museum of Modern Art, where the rebel painters have found a more agreeable shrine – after their first showing in the old Armory – have had the benefit of many a corroborative interpretation by the Museum officials. Of Marc Chagall,[14] the Museum catalogue calls attention to his "love for the incredible and bewitched." About Chirico,[15] there is the illuminating information that his paintings "were saturated with the sense of the mysterious and the occult."

Passion for Irrationality

The passion for the irrational has sent the rebel painter off into the fantastic and the subconscious. Iconographer of the intelligent and the intelligible, he has roamed with relish in the realm of psychic automatism, chance, double imagery, dream symbolism, hallucinations, and metaphysical experiences. His journey into the dark has been made, despite his loudly proclaimed antirational motives, with a carefully stated rationale. Thus, surrealist André Breton[16] has written: "The 'fantastic' . . . constitutes in our view the supreme means of fathoming the secret depths of history which disappear beneath the maze of events. It is only at the approach of the fantastic, at a point where human reason loses its control, that the most profound emotion of the individual has the fullest opportunity to express itself . . ." The objectless world of fantasy, the dimly remembered imagery of childhood, the brute *vital* of the primitive, the juxtaposed pattern of unrelated items, these seem to preoccupy the rebel painter. And the visible or measured world of rational science or the empirical life of the modern man seems to be only the butt of his vehemence. In his hand plastic form and linear rhythm have neither focus nor eye ease. The aim seems to be to shock and confuse.

Rebel artists, says Robsjohn-Gibbings[17] in his justly acclaimed study, have drawn a mustache across the face of Mona Lisa. Their paintings and their words

(*Concluded on page 244*)

Reg. U. S. Pat. Of

Samson Cordage Works

Boston 10, Mass.

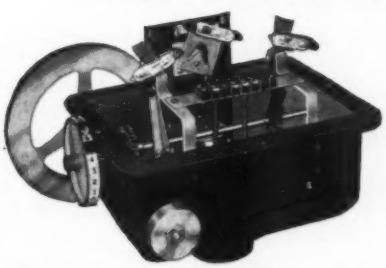
Manufacturers of braided cords of all kinds, including sash cord, clothes line, trolley cord, signal cord, shade cord, Venetian blind cord, awning line, etc., also polished cotton twines and specialties.

SPOT CORD

Reg. U. S. Pat. Of.

Our extra quality sash cord, distinguished at a glance by our trade-mark, the colored spots. Especially well known as the most durable material for hanging windows, for which use it has been specified by architects for more than half a century.

R F-2 ROTO-TROL with built-in ALTO-TROL



Puts that *Second Pump to work*

A 2-pump RF-2 ROTO-TROL with a built-in ALTO-TROL will operate each pump on alternate starting cycles, assuring equal use and wear of both pumps. It will operate both pumps if the demand requires.

This ROTO-TROL is furnished in a Cast Iron Cabinet. It is float operated through stainless steel tape. RF-2 is also available in from two to eight circuits for sequence control.

Depth Indicator is optional — extra.

The RF-2 Roto-Trol is especially adaptable to following installations:
Sewage Pumping Stations
Sewage Disposal Plants
Sewage Lift Stations
Water Storage Tanks
Water Works Reservoirs
Irrigation Control
Industrial Applications

WATER LEVEL CONTROLS DIVISION OF

Healy-Ruff Company

711 HAMPDEN AVE. ST. PAUL 4, MINN.

HEVI DUTY

1 Precision Electric Heat Treat Furnaces
(Laboratory and Industrial)

2 Surges Dry Type Air Cooled Transformers
(to 1000 KVA)

3 Constant Current Regulators *(Static Type)*

1 Hevi Duty Precision Electric Heat Treating furnaces are built in a large variety of types and sizes — for many heat treating operations — with temperature ranges to 2500° F (1371°C). They are standard production equipment in many national industrial plants.

2 Surges Quality Dry Type Air Cooled Transformers with or without tap changing switches as well as special transformers for special requirements.

3 Hevi Duty Constant Current Regulator (Static Type) for series lighting. To transform constant potential to constant current, using a resonant circuit with patented exclusive features. A decided improvement over any other known type of regulator.

Write for descriptive bulletins.

Harold E. Koch '22 President

Elton E. Staples '26 District Mgr., Cleveland

HEVI DUTY ELECTRIC COMPANY

HEVI DUTY

HEAT TREATING FURNACES • ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

THE CASE AGAINST THE REBEL PAINTERS

(Concluded from page 243)

both seem to substantiate his thesis. But why? There seems to be no easy answer.

Robsjohn-Gibbings seems to think there has been a conspiracy among the painters. "Modern art," he exclaims,[18] "is not modern at all. It is a revival of one of the oldest systems for getting power. It is a revival of magic."

More sympathetic and perhaps more convincing, English critic, Herbert Read,[19] feels that "there are conditions in modern life which give rise to a similar spiritual attitude in men, and to a similar expression of that attitude in art." He adds: "The modern artist, feeling himself no longer in any vital contact with security, performing no necessary or positive function in the life of the community, retreats upon himself, and gives expression to his own states of subjectivity, limiting himself to this expression." The dissociation so characteristic of rebel painting is traceable to the dissociation of the rebel painter from industrial civilization, and, as a result, from sensibility.

Whatever the explanation, in much of modern painting we find ambiguity in place of clarity, hallucinations instead of perceptions, subjective involution rather than objective orientation, experimentation in technique (for example, cubes, cones, and planes of the cubists), not experimentation in contexts.

The rebel artist has been painting a private mythology for a civilization which is in desperate want of a master myth.

References

[1] New York: Charles Scribner's Sons, 1931. $2.50.

[2] Janis, Sidney, *Abstract and Surrealist Art in America*, page 23 (New York: Reynal and Hitchcock, Inc., 1944), $6.50.

[3] Janis, *opus cited*, page 101.

[4] Janis, *opus cited*, page 102.

[5] Janis, *opus cited*, page 108.

[6] Robsjohn-Gibbings, Terence H., *Mona Lisa's Mustache: A Dissection of Modern Art*, page 101 (New York: Alfred A. Knopf, 1947), $3.50.

[7] Robsjohn-Gibbings, *opus cited*, page 108.

[8] Robsjohn-Gibbings, *opus cited*, page 138.

[9] Robsjohn-Gibbings, *opus cited*, page 149.

[10] Robsjohn-Gibbings, *opus cited*, page 150.

[11] Robsjohn-Gibbings, *opus cited*, page 158.

[12] New York: Dial Press, Inc., 1942. $7.50.

[13] Robsjohn-Gibbings, *opus cited*, page 179.

[14] Robsjohn-Gibbings, *opus cited*, page 241.

[15] Robsjohn-Gibbings, *ibid.*

[16] Breton, André, "Surrealism, Yesterday, Today, and Tomorrow," *This Quarter*, September, 1932, page 7 *ff*.

[17] Robsjohn-Gibbings, *opus cited*.

[18] Robsjohn-Gibbings, *opus cited*, page 13.

[19] Read, Herbert, *Art Now*, pages 115, 117 (New York: Harcourt, Brace and Company, 1934), $3.75.

WE'RE IN THE SECOND QUARTER OF OUR SECOND CENTURY

Consider the vitality of this or any business that has maintained its standing and reputation for such a very long time. It is proof above all proofs of Brooks' standards of good taste, Brooks' originality of design, Brooks' one hundred and thirty year old policy of making sure that men who buy here do well—both in dollar value received and in service rendered.

Ready-made Suits, $95 *to* $115

Sixth Floor Shop Suits, $70 *to* $85

ESTABLISHED 1818

Brooks Brothers

CLOTHING

Men's Furnishings, Hats & Shoes

346 MADISON AVENUE, COR. 44TH ST., NEW YORK 17, N. Y.

111 BROADWAY, NEW YORK 6, N. Y.

46 NEWBURY STREET, BOSTON 16, MASS.

727 WEST SEVENTH ST., LOS ANGELES 14, CALIF.

165 POST STREET, SAN FRANCISCO 8, CALIF.

40 Years of Service

QUITE A FEW **million Blue Prints and Photo Prints made by Electro Sun Co. as its humble but important part in the industrial growth of the country.**

AND

QUITE A FEW **of the nation's most prominent engineering and industrial firms are still doing business with us over a span of many years.**

A SERVICE FOR ENGINEERS BY ENGINEERS

ELECTRO SUN COMPANY, INC.

Blue Prints—Photo Prints—Photo Offset

161 Washington Street — 157 Chambers Street

Grand Central Terminal Building

NEW YORK, N. Y.

A. L. Weil '01 — J. C. Duff '86

THE MURRAY PRINTING COMPANY

A Complete Printing Organization

Letter Press · Offset · Binding

Wakefield • Massachusetts

EST. RP Co. 1874

ROGERS PEET Clothes are cut on our own patterns from our own imported and domestic selections of Woolens that rank among the finest in the world, and tailored to the industry's highest standards in our own New York workrooms.

Rogers Peet Clothes may be purchased in many cities in addition to New York and Boston where our own stores sell them. Many of the best-known retail merchants throughout the country are our accredited representatives.

If you will write us, we shall be glad to let you know how conveniently one of them may be located for your own requirements.

Rogers Peet Company

Makers of fine clothes

In New York: Fifth Avenue *at* 41st Street
Thirteenth Street *at* Broadway
Warren Street *at* Broadway
And in Boston: Tremont St. *at* Bromfield St.

SOIL CONSERVATION

(*Continued from page 224*)

or soils projects or extension projects, but a combination of these, with other specialized activities where needed, operated conjointly with such reorganization of farm procedure as the character of the land indicates as being necessary. The procedure is based on the best information in the possession of scientific agriculturists: – the agronomist, forester, range specialist, agricultural engineer, economist, extension specialist, game specialist, geographer, and others. It is the application of accumulated knowledge pertaining to the great multiplicity of variables affecting the three-phase process of absorption, runoff, and erosion, employed not as single uncoordinated implements of attack, but collectively, according to the needs and adaptability of the land, in a combination of integrated control measures, to be supplemented where necessary by new information accruing from the experience of combat.

This co-ordinated effort is perhaps the most vital element in the whole approach to erosion control. It represents a synthesis of the application of scientific knowledge and method.

The Conservation Farm Plan

Given a fundamental knowledge of soil erosion, a reasonable classification of land according to its capability for use, and the integration of numerous sciences pertinent to a broad program of erosion control, there still remains the problem of blueprinting specifications for the actual application of the job to be done. Conservation is not accomplished until it takes shape on the land. The land owner, or operator, must know and understand what needs to be done. To facilitate this, a conservation plan is written for each farm or ranch or other operating unit of land.

The plan consists of a map showing the land capability classes for the farm, delineated on an aerial photograph. Along with this map, or superimposed upon it, is a map of the most appropriate use of the land in accordance with its capabilities. Often, one of the first things that needs to be done to achieve conservation on the land, is to change the type of use. It is highly desirable that land now used for crops, but not suited for permanent cultivation, should be converted to grass or woodland. In some instances, land now in woodland or pasture can be safely cultivated. In order to bring use into conformance with inherent capabilities of the land, such land-use conversions are of paramount importance.

For each use, appropriate conservation practices are needed. For various classes of cropland, some of the practices recommended may be contour cultivation, strip cropping, terracing, crop residue management, and cover crops. On grazing land appropriate soil conservation practices are proper stocking, seeding, fertilizing, mowing, and stock-water development. In woodlands there may be tree planting, prevention of fire, and exclusion of grazing. On wild-life lands, such as marshes, there may be level ditching to improve the marshes for muskrat or waterfowl or other wild-life production.

Specifications for proper land use may often require considerable readjustment of the farm economy. Be-

cause of economic limitations of the farm operator, it is not always possible to follow exactly the recommended soil-and water-conservation practices called for by the land conditions. The guiding principle, however, is to bring the use of the land and the required conservation practices as close as possible to meeting the requirements set up by the conditions of the land. Thus, under some conditions, some land may be used more intensively than it should be. On land so used, erosion is very likely to be severe. On the other hand, land need not be used as intensively as it can be. Although much of New England is Class II and Class III land, capable of cultivation under limited restrictions of use, it is most profitably maintained in pasture and forest. Tilled crops from these lands can no longer compete with similar products from even richer croplands like those of the Middle West.

Summary

In the United States more than a half million farmers and ranchers have begun to remake their farms and ranches in accordance with individually designed soil- and water-conservation plans based on land capability surveys. This is only a fraction of the 6,000,000 farmers and ranchers in the United States, but it is a significant number, considering the newness of the subject, the readjustments sometimes required, and the complexity of the problems often encountered. In every case, the land operator, on the farm or ranch, is receiving the professional assistance of a soil conservationist who is trained to bring to the solution of the land problems the pertinent aspects of appropriate sciences that contribute to their solution.

In summary, let us review the points already covered. Soil is a complex, variable natural substance. Under conditions of use by man, soil erosion and soil depletion often proceed at a remarkably fast rate. Accelerated erosion has destroyed or greatly reduced the productive usefulness of large areas of land throughout the world. In the United States, public interest in erosion control has grown into a national program within the past two decades. This interest was first manifest by research on erosion, followed by passage of the Soil Conservation Act of 1935 and subsequent development of local action groups – soil conservation districts – in all 48 states, Hawaii, Alaska, and Puerto Rico. Fundamental to the carrying out of soil conservation work by land owners and operators is the land capability classification, which designates the limits of safe use. Based on the capability survey, appropriate soil- and water-conservation practices are recommended by soil conservationists who utilize appropriate information from a broad array of various sciences. On individual farms and ranches, land operators put into practice the land-use conversion and the soil- and water-conservation practices required to make the most productive use of the land over an indefinite period of time without deterioration of the soil resource.

HAROLD J. RYAN, INC.

Air Conditioning

101 PARK AVENUE NEW YORK 17, N. Y.

Doelcam Corporation

ELECTRONICS

GYROSCOPICS—SERVOMECHANISMS

DESIGN • DEVELOPMENT • PRODUCTION

56 ELMWOOD STREET, NEWTON 58, MASS.

TAKE A NUMBER

(*Continued from page 226*)

$4^2 + 5^2 = 41$. Fermat's statement is found to be true in all examples, but it took Euler seven years, with interruptions of course, to find a proof.

After everything that has gone before, the statement that every even number can be represented as the sum of two primes sounds as if it were one of Fermat's marginal scribblings, especially if one learns that there is no proof. Actually it was proposed in 1742 by the mathematician, Goldbach, and is therefore known as Goldbach's theorem or, more correctly, as Goldbach's conjecture. Goldbach himself did not claim to have a proof. Goldbach's conjecture merely worked, as the following few examples indicate:

$$\begin{aligned} 10 &= 7 + 3 \\ 20 &= 7 + 13 \\ 30 &= 29 + 1 \\ 40 &= 29 + 11 \\ 66 &= 61 + 5 \\ 84 &= 37 + 47 \end{aligned}$$

The method can be continued for as long as you have time. It was something that could be tried out by any schoolboy and found to work without fail, but it could not be proved. A hundred years after its origin there was no proof; 150 years after its origin there was still no proof; likewise in 1900, 1910, and 1920. Then, in 1931, L. Schnirelman took the first step, and some years later Vinogradoff actually proved that every even number must be a sum of four primes. Any example shows that two are enough, but proof for that is still lacking. But we are not finished with primes yet. One thing, that anybody who is interested in them will do first, is to count them. The result is that there are:

26 primes in the interval from 1 to	100
168 primes in the interval from 1 to	1,000
78,498 primes in the interval from 1 to	1,000,000
50,847,478 primes in the interval from 1 to	1,000,000,000

Naturally, the interval from one prime to the next increases as the figures grow. The largest known interval is between 4,652,353 and 4,652,507. But so far no law of any kind has been found to give the number of primes which may be expected in a given interval, except for an equation giving an approximate value. If n is the number of primes in the interval between 1 and the integer N, the number of primes is given (approximately) by the equation:

$$n = N / \log_e N$$

This equation indicates the presence of 22 primes in the first hundred (actually 26); 145 primes in the first thousand (actually 168); 72,382 primes in the first million (actually 78,498); and 48,254,942 in the first billion where there are actually almost 51,000,000 primes.

Public Opinion

That the public, probably as an aftermath of the much publicized Wolfskehl Prize, is still convinced that (*A*) mathematicians aren't so very bright, and that (*B*) there are tangible rewards for mathematical discoveries was experienced by the German mathematician Theodor Wolff in the late 1920's. Dr. Wolff wrote

(*Concluded on page 250*)

BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865

Boit, Dalton & Church

INSURANCE SINCE 1865

89 BROAD STREET, BOSTON 10 • *Telephone* HUbbard 2-3100

FREDERIC C. CHURCH CHAS. COLBY HEWITT JOHN W. GAHAN

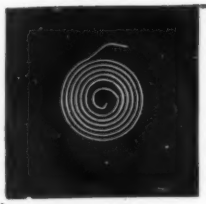
COLLINS GRAHAM STANLEY H. KING FRANK W. HUMPHREY

BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865 • BDC 1865

McCREERY and THERIAULT

Building Construction

126 NEWBURY STREET BOSTON, MASS.



PRECISION-GAUGED HAIRSPRINGS AND FINE ROLLED WIRE

PRECISION PRODUCTS COMPANY
WALTHAM, MASSACHUSETTS
ROBERT I. BRADLEY, '20

J. C. CORRIGAN CO., INC.
Conveyers
Engineers · Manufacturers · Erectors
Coal Handling Systems
Materials Handling Equipment
Portable Conveyors
Distributors for
Jeffrey Manufacturing Co.
Jeffrey Parts Carried in Boston Stock
41 Norwood Street, Boston 22, Mass.
Tel. GENeva 0800

Lord Electric Company
INCORPORATED
1895 ELECTRICAL CONSTRUCTION 1949

131 Clarendon Street
Boston 16, Massachusetts
Telephone CO 6-0456

10 Rockefeller Plaza
New York 20, N. Y.
Telephone CI 6-8000

1201 Plaza Building
Pittsburgh 19, Pa.
Telephone COURT 1920

The TREDENNICK-BILLINGS CO.
Construction Engineers ★ *Building Construction*

K. W. RICHARDS '07 H. D. BILLINGS '10 C. C. JONES '12 F. J. CONTI '34

10 HIGH STREET ★ BOSTON, MASSACHUSETTS

If It's Made — Ask ALBERT!

FOR IMMEDIATE DELIVERY
Odd and Large Sizes a Specialty
⅛" to 72"
LARGEST AND MOST COMPLETE STOCK on Atlantic Seaboard
Our Own Shop Facilities for Bending — Coiling — Welding — Threading and Testing —
Meeting All Standard Specifications
TUBE-TURNS, WELDING FITTINGS AND FLANGES

- **PIPE**: Electric Weld, Seamless, Spiral Weld, Lap Weld, Butt Weld, Steel—Wrought Iron, Corrugated Culvert
- **VALVES**: Iron Body, Forged Steel, Cast Steel and Special Alloys
- **FITTINGS**: Welding, Tube Turns Fabricated, Cast Iron, Forged Steel, Dresser, Victaulic
- **PILING**: ARMCO, Youngstown, Pile Points, Cobi-Pile Tips, Pile Sleeves, Cobi-Timber Tips

STAINLESS STEEL PIPE, FITTINGS AND VALVES

S. G. ALBERT '29, *Treasurer*

ALBERT PIPE SUPPLY CO., Inc.
No. 13th & Berry Streets, Brooklyn, N. Y. EVergreen 7-8100

WILLIAM D. NEUBERG CO., INC.

Chemicals

GRAYBAR BUILDING 420 LEXINGTON AVE.
NEW YORK 17, N. Y.
TELEPHONE OREGON 9-2550
CABLE—"WILNEUBERG"

Plans *Reports*
Specifications *Evaluations*
Supervision *Consultation*

HOLMES & NARVER
ENGINEERS
824 South Figueroa Street, Los Angeles 14

JAMES T. HOLMES
M.I.T. '14

D. LEE NARVER
Stanford '14

N. A. LOUGEE & COMPANY
ENGINEERS
Successors to J. H. Manning & Company

Reports—Appraisals—Depreciation Studies
Rate Cases—Business and Economic Studies

120 BROADWAY NEW YORK
N. A. LOUGEE '11 L. H. MATTHEWS '13
J. W. MCDONALD, JR. '20

SYSKA & HENNESSY, INC.
Engineers

Consultation **Plans** **Reports**
Power Plant **Water Systems** **Disposal Plants**

NEW YORK, N.Y.
J. F. HENNESSY '24

TAKE A NUMBER

(*Concluded from page 248*)

popular articles on mathematical problems in a German weekly magazine and one of these articles also dealt with primes. He stated that the largest prime then known was $2^{127} - 1$, and that proof had been obtained that the number was a prime. He explained what the expression $2^{127} - 1$ meant and added that its numerical value was unknown. But he added jokingly that there might be a *Dr. math honoris causa* for calculating it, and thereby Dr. Wolff invited trouble.

To his surprise (and horror) his readers took him seriously. Not realizing that the important (and difficult) job was to prove this figure a prime, they sat down and started calculating the numerical value, flooding the unfortunate author with letters, parcels, and wires, often cautiously stating only the beginning or the end of the figure and all asking where they had to apply for the honorary degree in mathematics.

Wolff's first job was to sit down and to calculate the numerical value of $2^{127} - 1$ himself. His second job was to reply to all the correspondence that had descended upon his desk, and also to get rid of a few people who called in person. In the end he presumably got out of the trouble he had caused himself. But the result of all this excitement about a nonexisting prize, in this case an honorary degree, was that the numerical value of $2^{127} - 1$ was calculated. It is:

170,141,183,460,469,231,731,687,303,715,884,105,727.

REFERENCES

Bell, Eric T., *Men of Mathematics* (New York: Simon and Schuster, 1937), $5.00.

Gamow, George, *One, Two, Three . . . Infinity* (New York: The Viking Press, 1947), $4.75.

Wolff, Th., *Der Wettlauf mit der Schildkröte* (Berlin, Germany: A. Scherl, 1929).

William H. Coburn, '11 **William F. Dean, '17**

William H. Coburn & Co.
INVESTMENT COUNSEL

68 Devonshire St. Boston, Mass.

PREPARATORY SCHOOLS FOR BOYS

CHAUNCY HALL SCHOOL

Founded 1828. The School that specializes in the preparation of students for the Massachusetts Institute of Technology.

Ray D. Farnsworth, *Principal* 553 Boylston Street, *Boston, Mass.*

HUNTINGTON SCHOOL FOR BOYS

Grades Nine to Twelve.
Thorough preparation for entrance to M.I.T. and other technical schools.
Regular and summer courses.
William G. Wilkinson, Headmaster
320 Huntington Ave., Boston Tel. Kenmore 1800

PROFESSIONAL CARDS

JACKSON & MORELAND
Engineers and Consultants

Design and Supervision of Construction
Reports — Examinations — Appraisals
Machine Design — Technical Publications

BOSTON NEW YORK

H. K. BARROWS, '95
M. Am. Soc. C. E.

CONSULTING HYDRAULIC ENGINEER

Hydro-electric Developments — Water Supplies. Reports, Plans, Supervision. Advice, Appraisals

6 BEACON STREET BOSTON, MASS.

EADIE, FREUND AND CAMPBELL
CONSULTING ENGINEERS

500 FIFTH AVENUE NEW YORK 18, N. Y.

Plans and Specifications — Examinations and Reports

Power. Heating. Ventilating, Electric, Plumbing, Sprinkler, Refrigerating, Elevator Installations, etc., in Buildings and Industrial Plants

J. K. CAMPBELL, M.I.T. '11

STARKWEATHER ENGINEERING CO.
INCORPORATED

Engineers and Contractors for Pumping Plants Boiler and Power Plants, Cooling Water and Heat Recovery Systems

246 Walnut Street, Newtonville BIGelow 8042

Wm. G. Starkweather, M.E. Cornell '92 — J. B. Starkweather, B.S. M.I.T. '21

THE KULJIAN CORPORATION
CONSULTANTS ✓ ENGINEERS ✓ CONSTRUCTORS

Specialists in

UTILITY, INDUSTRIAL and CHEMICAL FIELDS

1200 N. BROAD STREET PHILADELPHIA 21, PA.

H. A. KULJIAN, '19

FABRIC RESEARCH LABORATORIES
INCORPORATED

Research, Development and Consultation for Textile and Allied Industries

665 Boylston Street Boston, Mass.

W. J. HAMBURGER, '21 K. R. FOX, '40 E. R. KASWELL, '39

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

Malcolm G. Davis '25, *Vice President* Allen W. Reid '12 E. C. Edgar '35

Steam, Hydro, Diesel Power Plants; Industrial Structures; Plant Safety, Labor Relations, Utility Rates, Valuations, Reports; Large Scale Purchasing; Industrial Laboratory

New York, N. Y. Reading, Pa. Washington, D. C.
Philadelphia, Pa. Houston, Tex.

FAY, SPOFFORD & THORNDIKE
Engineers

Airports — Bridges — Water Supply and Sewerage
Port and Terminal Works — Fire Prevention

INVESTIGATIONS DESIGNS
SUPERVISION OF CONSTRUCTION

BOSTON NEW YORK

CLEVERDON, VARNEY & PIKE
Consulting Engineers

HERBERT S. CLEVERDON '10 WALDO F. PIKE '15

Structural Designs Foundations
Heating Ventilating and Plumbing Designs
Industrial Buildings, Reports, Investigations

120 TREMONT STREET BOSTON 8, MASS.

MAURICE A. REIDY
Consulting Engineer

BRIDGES BUILDINGS
STRUCTURAL DESIGNS FOUNDATIONS
CONSTRUCTION CONSULTANT AND ARCHITECTURAL ENGINEER

Estimates and Appraisals

101 TREMONT STREET BOSTON, MASS.

THE COSMA LABORATORIES CO.
1545 East 18th Street Cleveland 14, Ohio

Chemical Analysis — Testing — Consulting Engineering
Testimony and Research

H. SEYMOUR COLTON, M.I.T. '21, *Director* — R. W. FRISCHMUTH, Case '38, *Assistant Director*

MORAN, PROCTOR, FREEMAN & MUESER
CONSULTING ENGINEERS

420 LEXINGTON AVENUE NEW YORK 17, N. Y.

Foundations for Buildings, Bridges and Dams; Tunnels, Bulkheads, Marine Structures, Soil Studies and Tests; Reports, Design and Supervision

Pardo, Proctor, Freeman & Mueser
Ingenieros Consultores
Ap. Correos 614, Caracas, Venezuela

WILLIAM H. MUESER, '22

WILLIAM W. RUSSELL '22 EDGAR P. PALMER '25

PALMER RUSSELL CO., *Realtors*

1320 Beacon Street Brookline 46, Massachusetts

COMPLETE MORTGAGE SERVICE

Business Loans to Corporations and Institutions

Loan Correspondent for the Penn Mutual Life Insurance Company

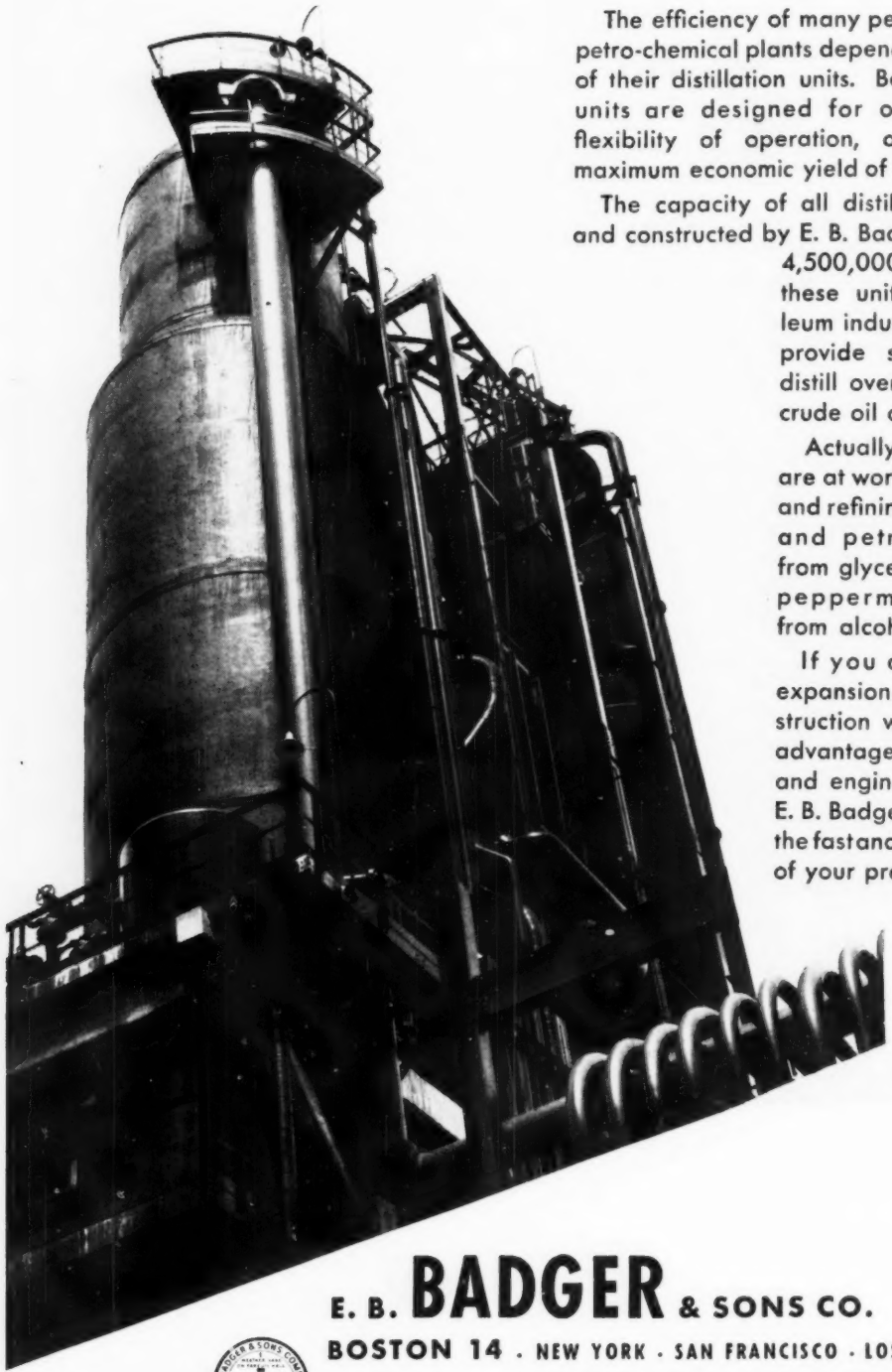
---

FAirmount 5105 EXpress 7766

FRANK MASSA
Electro-Acoustic Consultant

3393 Dellwood Road 3868 Carnegie Avenue
CLEVELAND, OHIO

A FUNDAMENTAL COMPONENT...



The efficiency of many petroleum, chemical and petro-chemical plants depends on the performance of their distillation units. Badger-built distillation units are designed for on-stream efficiency, flexibility of operation, accurate control and maximum economic yield of specification products.

The capacity of all distillation units designed and constructed by E. B. Badger & Sons Co. totals 4,500,000 barrels a day. If all these units were in the petroleum industry alone, they would provide sufficient capacity to distill over 80% of the national crude oil output.

Actually, of course, these units are at work distilling, separating and refining all sorts of chemical and petroleum products — from glycerin to gasoline, from peppermint oil to phenol, from alcohol to asphalt.

If you are planning plant expansion or new plant construction we invite you to take advantage of the broad process and engineering experience of E. B. Badger & Sons Co. to assure the fast and successful completion of your project.

E. B. BADGER & SONS CO. **Est. 1841**

BOSTON 14 · NEW YORK · SAN FRANCISCO · LOS ANGELES · LONDON

A SUBSIDIARY of STONE & WEBSTER, INC.

PROCESS ENGINEERS AND CONSTRUCTORS FOR THE CHEMICAL, PETROLEUM AND PETRO-CHEMICAL INDUSTRIES

Condor's Compensation Principle

. . . Prolongs the Life of This Belt

This 16" Condor Compensated Belt is operating the main drive in a large southern lumber mill. Note the two large idler pulleys are putting considerable strain on this belt. However, when the photo was taken, this Condor Belt had already been in service 3 years. The pleased owners reported,

"This belt has outworn all others and looks good for at least three more years."

On lumber mill drives, factory line shafts, big pumps, generator drives, etc., Condor Compensated Belts "outwear the field", because they are engineered for equalized ply stresses.

In regular belt construction, the outer plies take excessive strain when flexed over pulleys. The inner plies "relax" as the inset shows. Condor's Compensation Principle insures equal pull in every ply regardless of size of pulleys or load and tension. Make Condor Compensated your choice for drives demanding extra belt strength and long service.

Manhattan offers a range of four driving tension surfaces on rubber transmission belts. Also Endless Cord, Non-Spark, Oil-Proof and Acid-Proof constructions. Belts can be factory-made endless or field vulcanized by the Condor-Weld method. All Manhattan endless belts have the patented Extensible-Tip outer-ply splice which prolongs belt life 3 to 10 times. Literature on request.

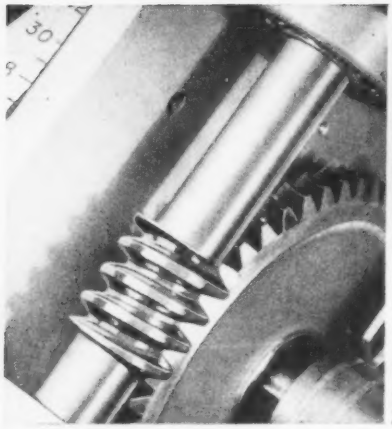
RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN INC.

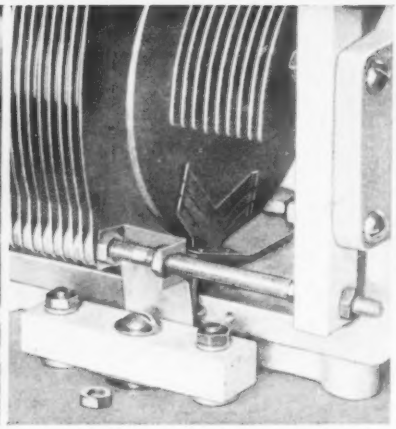
Keep Ahead with Manhattan

MANHATTAN RUBBER DIVISION **PASSAIC, NEW JERSEY**

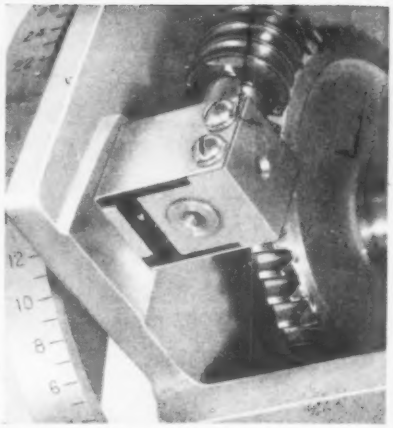
Thomas H. Boyd, '23 Wilder E. Perkins, '25 Charles P. McHugh, '26 Daniel J. Hanlon, '37 Albert W. Beucker, '40



This 50-to-1 worm drive, equipped with a 3½ inch dial, is used for the fine setting adjustment. Backlash is kept very low by spring pressure on the worm shaft. Eccentricity from set screws and misfit is eliminated by cutting the worm and its shaft from an integral steel shafting.



Two small, waxed steatite bars insulate the stator plates. A Figure of Merit (Dissipation Factor x Capacitance) of 0.04 μμf is secured (0.003 μμf with quartz insulators). Connection to the rotor is through spring-tempered silver alloy brushes bearing on a silver-overlay brass disc.

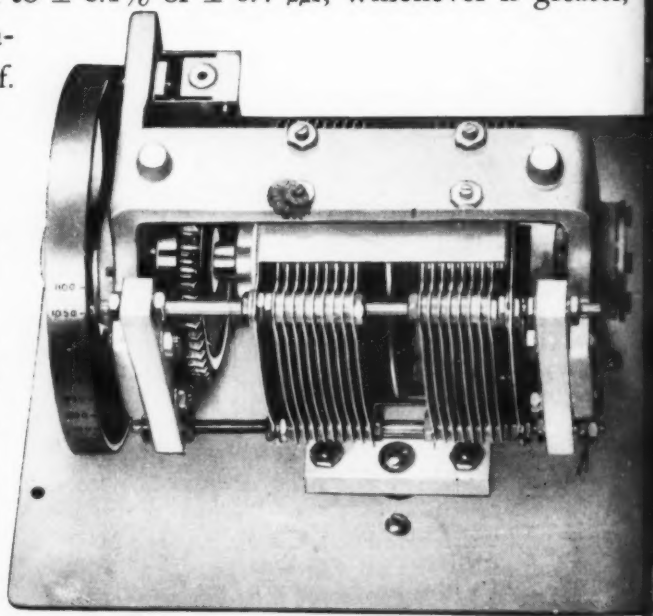


The worm shaft is held to a tolerance of 0.0004 inch, radial eccentricity of the worm gear is less than 0.002 inch. The main rotor shaft is held to a tolerance of 0.0005 inch and its bearing surfaces to 0.0002 inch. Ball bearings are used on worm and main rotor shafts.

The STANDARD of Variable Capacitance

Recently the accuracy of the well-known G-R Type 722 Precision Condensers has been increased, making these standards of variable capacitance of even greater use in the laboratory and as the variable element in many instruments such as oscillators and frequency meters.

Typical of the three different models of this condenser is the Type 722-N, with extra low metallic resistance and inductance. This condenser (illustrated) is direct reading to ± 1 μμf. When the corrections (charted on the front panel) are applied to the direct-reading settings the accuracy is increased to ± 0.1% or ± 0.4 μμf, whichever is greater, and the corresponding accuracy for capacitance differences is ± 0.1% or ± 0.5 μμf.



SPECIFICATIONS

- **CAPACITANCE RANGE:** 100 to 1100 μμf, direct reading
- **STANDARD CALIBRATION:** Direct reading in μμf at 1 kc to ± 1 μμf. Mounted correction chart gives corrections to 0.1 μμf at multiples of 100 μμf.
- **WORM CORRECTION:** For very precise measurements a worm correction calibration can be supplied. When these are applied capacitance can be determined within ± 0.1 μμf or ± 0.1%, whichever is greater, and capacitance differences to ± 0.2 μμf or ± 0.1%
- **METALLIC RESISTANCE:** Series resistance about 0.008 ohm at 1 Mc
- **SERIES INDUCTANCE:** Approximately 0.024 μh
- **TEMPERATURE COEFFICIENT:** Approximately 0.002% per deg. C.

● **TYPE 722-N PRECISION CONDENSER**	$160
Worm Correction Calibration	50
Quartz Insulation	85

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

inch,
.002
.005
rings

has
use
ators

extra
g to
rect-
ater,

$160
50
85